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West Point, New York 10996**

**ANNUAL REPORT  
OF THE  
OPERATIONS RESEARCH CENTER  
AND  
DEPARTMENT OF SYSTEMS  
ENGINEERING  
FOR  
ACADEMIC YEAR 2002**

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## **PART I - The Operations Research Center of Excellence (ORCEN)**

### ***Purpose of the Operations Research Center***

The purpose of the Operations Research Center is to provide a small, full-time analytical capability to both the Academy and the United States Army. The Operations Research Center helps to fill several Academy needs:

- 1) enriched education for cadets;
- 2) enhanced professional development opportunities for Army faculty;
- 3) strong ties between the Academy and Army agencies; and
- 4) the integration of new technologies into the academic program.

By being fully engaged in current Army issues, the Operations Research Center assures that systems engineering education at West Point remains current and relevant. The one-year experience tour with the ORCEN offers officers assigned to the Academy as faculty the opportunity to engage in meaningful applied research and problem solving activities that both further enhances their soldierly professional development and keeps them current in their discipline. The Army's return on its investment is meaningful career development experiences for officers, especially those in Functional Areas 49/51/53, and important investigation of vital Army problems at far less cost than would be required through civilian contracts.

Operations Research Center projects provide the faculty and cadets with the opportunity to investigate a wide spectrum of interdisciplinary, systemic issues and to apply many of the systems engineering, engineering management, and operations research concepts studied in the classroom to real-world problems of interest to the Army. These projects demonstrate for both cadets and faculty the relevance and importance of systems engineering in today's high technology Army.

### ***Organization of the Operations Research Center***

Personnel authorizations in the ORCEN are established by a Table of Distribution and Allowances (TDA). Funding support for the Operations Research Center is established by a Memorandum of Agreement with the Office of the Assistant Secretary of the Army (Financial Management & Comptroller). The Operations Research Center is organized under the Office of the Dean as an Academy Center of Excellence. A permanent Military Academy professor provides oversight and supervision to the Center. In addition, the TDA authorizes one analyst, O5; three analysts, O4; and one secretary, GS5. By

agreement between the Department of Systems Engineering (D/SE) and the Department of Mathematical Sciences (D/MATH SCI), three analysts are assigned to the ORCEN by D/SE, and one analyst comes from the D/MATH SCI. The Department of Systems Engineering also provides the permanent faculty member to serve as the Director. The Operations Research Center welcomes the opportunity to collaborate on Army-related projects with USMA teaching faculty from the Departments of Systems Engineering, Mathematical Sciences, and others. In addition, the ORCEN is able to provide Army officers attending graduate school and cadets enrolled in advanced individual study courses with real-world projects that are well suited for either thesis work or course projects. This in turn provides Army agencies with a greater range of expertise to address a wide spectrum of projects.

The Operations Research Center occupies office and laboratory space in the Department of Systems Engineering on the third floor of Mahan Hall. The Center includes offices for the director and analysts, and a briefing area. The Department of Systems Engineering laboratories -- Combat Simulation, Systems Management and Design, Computer Aided Design, and Installation Management and Engineering -- are located within easy access to the Operations Research Center.

The Operations Research Center is sponsored by the Assistant Secretary of the Army (Financial Management & Comptroller). Fully staffed and funded since Academic Year 1990-1991, the Operations Research Center has made significant contributions to cadet education, faculty development, and the Army at large.

## ***Personnel***

The following is a list of the Operations Research Center positions and personnel assigned during FY02:

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These full-time analysts are augmented by permanent faculty who serve as senior investigators for each project, as well as by instructors from the Department of Systems Engineering, the Department of Mathematical Sciences, and other departments who work

as primary analysts or co-analysts on ORCEN projects. Contributors for AY02 are listed in the following table.

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## ***Laboratory Resources***

### **Systems Management and Design Lab (SMDL)**

This lab is designed to facilitate group design work, ideation and sharing. Presentation and conferencing facilities are part of the lab. The principle function of the lab is to facilitate cadets working as groups as they move through the systems engineering design process, particularly the formulation and interpretation of alternatives steps. A secondary purpose is to provide a sophisticated meeting and briefing place for all kinds of groups with the capability to enhance their work. Lab equipment is designed to be reconfigurable to accommodate different size groups and organizations.

The lab's 18 workstations have Pentium III/Dual 933 MHz processors, 512 MB RAM, 18 GB hard drives, Diamond Fire GL1 video cards with 32 MB of RAM, and 18" flat panel displays. This capability allows cadets to use advanced software and peripherals for high-speed data processing and high quality graphics. One of these workstations is used as the facilitator's workstation while the others are nodes in the CSCW software package (GroupSystems V).

### *Installation Management and Engineering Annex*

The Installation Management and Engineering Annex (IMEA) to the SMDL provides cadets and faculty with the tools needed to study installation management and power projection related issues. Engineering Management cadets use Geographic Information System (GIS) and other engineering analysis software in the Introduction to Systems Design for Engineering Managers (SE411) as well as in the follow-on capstone design courses (SE421). Other cadets use the facility to conduct in-depth research in advanced individual study courses (SE 489).

The hardware configuration of the IMEA consists of 10 workstations which have Pentium III/Dual 933 MHz processors, 512 MB RAM, 18 GB hard drives, Diamond Fire GL1 video cards with 32 MB of RAM, and 18" flat panel displays.

### *Combat Simulation Laboratory*

The Combat Simulation Laboratory (CSL) offers state-of-the-art simulation and analysis tools for virtual prototyping, testing and evaluation in distributed and non-distributed environments. Cadets combine premier Army simulations and commercial-off-the-shelf (COTS) modeling tools to gain insight into real-world Army problems. Cadets build a foundation in Combat Modeling (SE 485) and apply their knowledge in System Design I and II (SE 402/403) and in Advanced Individual Study in Systems Engineering or Engineering Management (SE 489). ORCEN analysts and department faculty use the facility to approach a variety of problems.

Janus, OneSAF TestBed, JCATS, and ITEMS are the primary simulations. JETS, the Janus Evaluator's Tool Set, is the main analysis tool and simulation browser. Simulation output may be analyzed directly through JETS or exported to a variety of other tools, such as Minitab. COTS tools include MultiGen Creator Pro 3D modeling software. Hardware includes an Onyx Infinite Reality computer, 5 Hewlett-Packard Unix computers, and 18 PC workstations with 2 GHz processors, 512 MB RAM, 40 GB hard drives and 17" flat panel monitors. All hardware is networked through a Cisco 6000 switch to the Internet via fiber optic cable.

### *Computer Aided Systems Engineering Laboratories I and II*

Two identical CASE laboratory facilities provide 36 workstations for general support to DSE courses. Each workstation offers standalone simulation capability with packages including ProModel. Decision support packages including the PrecisionTree ToolSuite combine with analysis and optimization packages such as Premium Solver and MiniTab. Collaborative and active learning is enhanced through SynchronEyes, which allows

student workstations to be shared throughout the classroom. Instructors also use SmartBoard touch technology projection screens.

These computers have 2 GHz processors, 512 MB RAM, 40 GB hard drives and 17" flat panel monitors.

**Mobile Technology Classroom**

The Mobile Technology Classroom (MTC) provides powerful, reconfigurable computing to any classroom. The full suite of DSE office and simulation software is installed on notebook computers with wireless local area network connections to enable any department course to utilize common applications in the classroom. Computers are housed in a high-security cart that provides a network access point, printer and recharging capability.

The computers contain 1.13 GHz Pentium III processors with 512 MB RAM, Nvidia video cards with 32 MB RAM, 2 batteries for 6-hour continuous operation, 20 GB hard drives, CD ROM and 100 Megabit internal LAN card and 802.11a wireless PC LAN cards.

## **PART II – Principal Research Activities – AY02**

### **Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)**

**Client Organization:** Army Research Labs, Battlefield Environment Division,  
Computational and Information Sciences Directorate – White Sands Missile  
Range, New Mexico

**Principal Analysts:** CDTs Pierre Han, Scott Stroiney, Charles Russ, Adam Heppe  
**Senior Investigator:** LTC James M. Buckingham, P.E., Ph.D.

#### **Points of Contact:**

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#### **Problem Statement:**

The Computational and Information Sciences Directorate of the Battlefield Environment Division of the Army Research Laboratories is currently in the process of developing a smart weather sensor web for use on the battlefield. The project is intended to provide a design for a packaged suite of sensors to collect weather information from remote locations on the battlefield. The sensor package will be rapidly deployed by air and integrated in a web-based structure to support battlefield environment information requirements. The package will collect such information as: visibility, ceiling, temperature, dew point, barometric pressure, wind direction and wind speed. Ultimately this information will be used to provide real-time aviation weather for both mission planning and targeting. In addition it will support real-time battlefield environment information for maneuver units. It may assist in both target acquisition and unit detection. Finally it provides situational awareness by supplementing information from satellite imagery and providing an “under-the-weather” view of the battlefield. Currently, the U.S. Army has no ground-based, rapidly deployable weather collection system to collect hard weather data in a timely fashion and provide it to their weather forecasting model. This project seeks to fill that gap.

#### **Scope of Work and Methodology:**

This project is called the Disposable, Air-droppable, Meteorological Tower Array (DAMTA). The research will primarily involve a preliminary design for the platform that will move the sensor package from the airborne platform to the ground. The results

of this research are to be provided through Army Research Labs at White Sands Missile Range, NM to the company receiving the contract to design and build prototypes of this device.

This research was performed in part as a senior Capstone project by four cadets from the U.S. Military Academy studying Engineering Management. Under the auspices of the senior investigator, the cadet team performed a complete systems analysis of the problem. This included an investigation of the stakeholders, the effective need, development of alternatives, comparison of alternatives, selection of the best alternative and communication of the results to the client agency. The following primary elements were included in the study:

- Definition of the problem within the specifications provided by the client.
- Value System Design – This provides a model against which alternatives can be measured.
- Synthesis of Alternatives – This involves developing options for safely conducting the transport of the sensor package from a moving airborne platform to the ground where it will be deployed, then creating viable competing alternatives from the feasible options.
- Interpretation of Alternatives – This will involve the development of a model based on the value system design to compare and rank the alternatives and recommend the best design for such a platform to ARL to be integrated into the SBIR Phase II winner's prototype design for the DAMTA.
- Desktop prototype of the selected alternative.
- Communication of the results to the host agency and other interested agencies.

### **Results Summary:**

All elements of the scope of work described above were completed on time and presented on 8 May 2002 to Dr. Jon J. Mercurio, Chief, Battlefield Environment Division at the annual USMA projects day conference. The work was well received. Copies of the final report were mailed on 11 Jul 2002 to Dr. Mercurio and to Dr. Doug Brown at White Sands Missile Range, NM, the primary client.

The DAMTA is a proposed new combat weather collection device that is being designed to increase the accuracy of the Battle Forecast Model, the Army's weather forecasting model. This research was focused on designing a mechanical platform to safely transport the DAMTA from an aerial vehicle to the ground and initiate operation. We were not tasked to design the actual sensors or relay technology.

Following the Systems Engineering Design Process (SEDP) the analysts performed a stakeholders analysis and created an input-output model in order to construct a more focused effective need. They identified 5 functions that the platform must accomplish in order to complete its mission successfully. These functions are deceleration, landing, self-righting, securing position, and deploying any external sensors. Next they identified several options that could accomplish each of these tasks. These options were screened for feasibility.

Armed with a collection of feasible options, eight alternatives were proposed that could successfully accomplish all five essential functions. A Multi-Objective Decision-Making Model with a table look-up chart was used to generate scores so that the alternatives could be compared. Through a set of weighted criteria and sub-criteria, which included cost, size, weight, reliability, weatherability, and simplicity, we were able to optimize the alternatives. After presenting the findings to Army Research Labs on 3 April 2002, they agreed with the primary alternatives suggested with some minor revisions. These revisions were incorporated into the design and a desktop prototype was built and presented at the final briefing on 8 May 2002 at the U.S. Military Academy at West Point, NY.

This design incorporated a collapsible parachute; solid body construction and spring-loaded legs. This alternative was developed into a prototype in order to identify any problems with the initial design. Although we did not construct a full-scale prototype, several ways were identified to decrease weight and increase strength of the model. Some of these included using a lighter alloy body, while increasing leg and hinge strength.

We anticipate that ARL will be able to pass the recommendations from this analysis on to Applied Technologies Incorporated, who has won the bid for building 20 fully functioning DAMTA prototypes over the next two years.

This project included several trips to conduct coordination, briefings and research. Specifically, trips were conducted as follows:

- Dec 2001 - Senior investigator traveled to White Sands, NM to meet with client.
- Feb 2002 - Senior investigator traveled to Fairbanks and Anchorage, AK to meet with representatives of the Federal Aviation Administration (FAA), the University of Alaska Geophysical Institute (GI), the National Weather Service (NWS) and the Aircraft Owners and Pilots Association (AOPA) reference state-of-the-art in integration of imagery products with weather collection. This trip was conducted in part to secure continued support for research on this project in FY03.
- Apr 2002 - Senior investigator + 4 cadets traveled to White Sands Missile Range, NM to present decision briefing on alternatives.
- Jun 2002 - Senior investigator traveled to Alaska to meet with representatives of FAA, NWS and the Bureau of Land Management to present results of research to appropriate agencies and integrate their recommendations into final report to client. In addition, this trip was used to conduct background research for AY 02-03 research/capstones that will be conducted by the senior researcher.

#### **Presentations and Publications:**

- Buckingham, James M.; Han, Pierre; Heppe, Adam; Russ, Charles; Stroiney, Scott, Capstone Final Report: *Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)*, June 2002.

- Han, Pierre; Heppe, Adam; Russ, Charles; Stroiney, Scott, Department of Systems Engineering Projects Day Presentation: *Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)*, May 2002.

**Personnel Briefed:**

- Dr. Jon J. Mercurio, Army Research Labs, Chief, Battlefield Environment Division, West Point, NY – 8 May 2002
- Dr. Doug Brown, Army Research Labs, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002
- Mr. Mike Alexander, Army Research Labs, Meteorologist, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002
- Ms. Barbara Sauter, Army Research Labs, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002
- Mr. John Dragomir, National Weather Service Office, Fairbanks, AK, 20 June 2002
- Ms. Sharon Alden, Fire Protection Services, Bureau of Land Management, Fairbanks, AK – 21 Jun 2002
- Mr. Walt Wilson, Federal Aviation Administration, Anchorage, AK, 24 Jun 2002

**Status:** Complete. Follow-on work to this project will be continued during FY 03 by the Senior Investigator.

## **Hybrid UAV/UGVs**

**Client Organization:** Advanced Systems Directorate, Aviation and Missile Research Development and Engineering Center, US Army Aviation and Missile Command, Redstone Arsenal

**Principal Analysts:** CDTs Christopher Alvear, Patrick Sheets, Luke Walker, Sarah Wolberg, and Charles Woodruff  
**Senior Investigator:** Dr. Roger C. Burk, Ph.D.

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Mr. Alfred R. Reed	ATTN: AMSAM-RD-AS Building 5400 Redstone Arsenal, AL 35898-5000	256-313-2408	alfred.reed@rdec.redstone.army.mil

### **Problem Statement:**

Develop a system concept for a tactical unmanned vehicle with both air and ground movement capabilities. The client believes that a vehicle that could move both in the air and on the ground would have important advantages for some tactical missions. By landing, it could stay on station longer than an air vehicle, and could perhaps inspect things at closer range or find a hide location for further observations. On the other hand, it could move more rapidly than a ground vehicle to respond to a changing situation, and it could fly over obstacles. The client has developed a candidate set of system requirements for such a hybrid vehicle, and is interested in developing a system concept that meets them, and possibly in research into how such a system could be employed. The target time period for deployment is about 2020.

### **Scope of Work & Methodology:**

The first half of the project centered on understanding the problem area, investigating alternative technical approaches:

- Background research on tactical Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs)
- Review and analysis of previous work on hybrid vehicles and client's requirements statement
- Functional analysis of proposed system
- Research on possible future technologies relevant to the system

- Application of SEDP methodology to the problem to develop alternative system concepts
- Identification and recommendation of the most promising

After a mid-project review briefing with the client, we concluded that the most pressing requirement for continuing the research was a better understanding of the military utility of the proposed hybrid vehicle, to give us better criteria for selecting the best technical approach. We developed a way to model the hybrid vehicle in the Janus tactical simulator and compared its performance to that of a notional future UAV.

### **Results Summary:**

We used two approaches for requirements analysis for the hybrid vehicle: Qualitative and Quantitative. The qualitative analysis focused on examination of four scenarios: Forward Observer, Scout, Reconnaissance, and Surveillance. Each of this was considered in daytime and nighttime variations. Our hope was one or two of these would stand out as illustrating more convincingly than the others the military utility of a hybrid vehicle, and so provide a focus for further investigations. However, this did not turn out to be the case, and all eight scenarios seemed about equally compelling. We did conclude that actual movement on the ground seemed to play a relatively limited role for the hybrid vehicle; ground movement was generally only for short distances to find a hide location or observation point. On the other hand, ability to land in the field played an important role in increasing endurance in surveillance missions.

The quantitative approach involved using Janus to run a detailed tactical-level discrete-event simulation of a hybrid vehicle, in order to compare its performance to a conventional UAV alternative. Since Janus had never been used to model a hybrid system, the focus of the research was on proof of the concept and demonstration that we could devise a way to use Janus for this purpose. This was successful, and a set of runs was completed for a Reconnaissance mission. The results showed a significant military benefit for the hybrid vehicle, which detected enemy soldiers 27% more often than a UAV. However, the marginal benefit seemed small compared to the greatly increased complexity of a hybrid vehicle. Furthermore, the hybrid vehicle took longer to accomplish the mission, and was more vulnerable to hostile action. These results were only confirmed for the single scenario run.

### **Presentations and Publications:**

- Burk, Roger C.; Alvear, Christopher; Sheets, Patrick; Walker, Luke; Wolberg, Sarah; and Woodruff, Charles. Presentation at the Military Operations Research Society, Working Group 10 (Unmanned Systems): *Analysis of Alternatives for a Tactical Hybrid UAV/UGV*, Ft. Leavenworth, KS, 18-20 June 2002
- \_\_\_\_\_, DSE Technical Report: *Analysis of Alternatives for a Tactical Hybrid UAV/UGV*, in preparation

**Personnel Briefed:**

- Dr. Suzy Young (Deputy Director) and Mr. Al Reed, Advanced Systems Directorate, AMRDEC, May 2002 (via e-mail)

**Status:** Work complete. DSE Technical Report in preparation. In discussions with client regarding possible follow-on work in AY03 or AY04.

# An Agent-Based Modeling Approach to Measuring the Value of a Proposed Information System

**Client Organization:** TRADOC Analysis Center – White Sands Missile Range

**Principal Analysts:** MAJ Larry R. Larimer, M.S., MAJ Robert H. Kewley, Jr., M.S.  
**Senior Investigator:** COL William B. Carlton, P. E., Ph.D.

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## Problem Statement:

For several years the U.S. Army and Department of Defense have struggled with how to measure the value of battlefield information. Digital information systems have demonstrated the potential to significantly increase the combat effectiveness of our forces, but in order to make procurement, force structure, and basis of issue decisions, we would like to gauge the extent to which these systems increase combat effectiveness. This research describes a methodology we chose to investigate whether an agent-based-model (ABM) could be used to suggest appropriate behaviors for a combat force equipped with a proposed information system such as Future Battle Command Brigade and Below – FBCB2. The decision agents within the model will use the information about enemy forces, friendly forces, and terrain provided by the proposed information system to adjust the friendly course of action to the updated situation.

## Scope of Work & Methodology:

Our methodology is a three-step process:

1. We first execute simulation runs using an existing dynamic study scenario and evaluate the results of these runs.
2. In the second step, we transfer the terrain, units, and course of action from the existing dynamic scenario to an ABM with intelligent agents that will refine the course of action genetic algorithm by generating new unit positions and routes based upon the current situation.
3. In the final step, we substitute the ABM developed course of action and behaviors back into the dynamic study scenario and execute another set of simulation runs.

The performance of the friendly force using the proposed information system and ABM generated behaviors may be compared to the performance of the friendly force which failed to take advantage of current information. This gives insight into the potential increase in combat effectiveness realized through the use of an information system.

### **Results Summary:**

The agents dynamically controlling unit movements during the scenario sought to maximize the military value of the positions occupied by the units in the simulation. The military value of a piece of terrain was determined by a weighted average of several factors. The first factor was the rate of attrition of the unit against known enemy. This rate of attrition was calculated considering line of sight, vegetation, and the size and composition of units in the current enemy situation. The second factor was the enemy rate of attrition against the unit. The third factor was the number of enemy units to which line of sight exists. The agents also considered the distance to the evaluated location from the current position and the time required to move there. The weights of these factors depended on the unit mission. An attacking unit would weigh heavily the rate of attrition against the enemy. On the other hand, a unit conducting reconnaissance would weigh heavily the number of enemy units to whom line of sight exists while minimizing the enemy rate of attrition against himself.

Two different agents used the value of terrain to control movement. A position agent used a uniform random search to search discrete points in a circular area around the unit for a better position. The size of the circle depended upon the amount of flexibility given to the unit in its orders. If a better position with a higher military value than the unit's current location was found, the unit moved to that position. A genetic algorithm randomly generated and evaluated routes to the new location in an attempt to maximize the average military value of the terrain traversed along the route. These two dynamic agents positioned units on better terrain, given the current enemy situation, than they had in their original orders.

In a company-sized unit in this scenario, the company which allowed dynamic agents to update the positions of its platoons killed an average of 3.8 times more enemy forces than the company which adhered to the original routes generated by the scenario developer. This increase was statistically significant, and there was no significant change in the number of friendly casualties.

This research showed the potential for decision agents within a constructive simulation to make use of tactical information in order to generate new orders and increase combat effectiveness. The next logical step in this research is to incorporate similar agents into existing tactical simulations, such as Combat XXI. This combination would allow analysts to measure combat performance of these agents, given different levels of tactical information, in order to estimate the tactical value of that information.

### **Presentations and Publications:**

- Kewley, Robert H. and Larry R. Larimer, Presentations at the Military Operations Research Society Symposium, Working Group 6 (C4ISR) and Working Group 29 (Modeling, Simulation, and Wargaming): *An Agent-Based*

*Modeling Approach to Measuring the Value of a Proposed Information System,*  
US Army Command and General Staff College, Ft. Leavenworth, KS, June  
2002.

**Status:** Research complete, technical report pending.

## **Analysis of USMA Cemetery Utilization**

**Client Organization:** The USMA Directorate of Logistics (DOL)

**Principal Analysts:** CDTs Chris Staab, Jonathan Johnson,  
Brandon McCray, Matthew Chase  
**Senior Investigator:** COL William B. Carlton, P. E., Ph.D.

### **Points of Contact:**

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. John Mandia	USMA DOL	(845) 938-7323	YJ7755@usma.edu

### **Problem Statement:**

Currently the USMA cemetery faces saturation (the condition of having no remaining grave sites) at an unknown date. If saturation occurs no new burials will be allowed at the cemetery. The USMA DOL wants a new evaluation of the expected date of saturation as well as proposals for how the saturation date might be extended.

### **Scope of Work & Methodology:**

This year-long a cadet capstone project satisfied the academic requirements for SE402 and SE403. The cadet team researched:

- All available statutory requirements and regulations pertaining to the USMA Cemetery as a functioning cemetery on federal property.
- All religious and historical implications of eligible members who may be interred (or inurned) in the cemetery.
- Interview all pertinent stakeholders and collect graduation, mortality and burial data related to the USMA cemetery and others eligible.

This data was used to forecast and/or simulate future burial rates allowing a reasonable estimation of the cemetery's saturation date. Research required cadets to exercise many of the lessons learned in Systems Engineering program and the Core Academic program.

The cadet design team formulated several reasonable alternatives that were evaluated, analyzed and presented to the decision maker who is using the results of this analysis to form decisions regarding future cemetery utilization and upgrades.

## **Results Summary:**

### **1. Systems Analysis**

The first step in the systems analysis was to determine the primitive need. From the information gained during the interview with our primary client, Mr. John Mandia, the primitive need encompassed the following major goals and objectives for the USMA Cemetery:

1. Find the saturation rate for the cemetery and use it to predict when the cemetery will be fully saturated
2. Identify and recommend alternatives that may help to extend the life of the cemetery.

From these goals and objectives, the team developed the following primitive need statement:

*To provide an accurate assessment of the time to saturation so that the life of the cemetery may be lengthened.*

The primitive need guided the team in determining who needed to be contacted in order to complete the stakeholder analysis. The stakeholder analysis primarily consisted of interviews that were conducted with members of the Academy that may have a vested interest in the Cemetery Project. These people included chaplains from the Catholic, Protestant, and Jewish faiths, a representative from Hogan's Funeral Home in Highland Falls, NY, members of the Association of Graduates, the USMA Mortuary Officer, a member of the Memorialization Committee, the head of the Directorate of Housing and Public Works, and the USMA Master Planner. From these interviews, the team developed the following effective need statement:

*To assess the remaining useful life of the USMA Cemetery and to provide alternatives for continued burial service and space for all eligible persons for an indefinite period of time in order to satisfy all legal, religious, and historical requirements and financial considerations while upholding good public relations.*

From this effective need the team created a value hierarchy that was used to evaluate the alternatives.

### **2. Data Analysis**

From a data analysis standpoint, the problem consisted of depicting the saturation rate for the USMA Cemetery and providing the life expectancy for each feasible alternative. The approach evaluated the data from the Graves Data Base, a Microsoft Access database used to record the interments of the cemetery. This approach was divided into two parts: 1) developing our entry rate of interments into the cemetery through Graduate, Non-Graduate, Dependent and Exception Rates, and 2) developing the breakdown of those interments once they were in the cemetery. The breakdown of interments consisted of cremation, full body, new plots, and old (existing) plots. Based on our analysis the team concluded that the entry rates for non-graduates and exceptions remain constant, but the entry rate for graduates increases over the years, along with dependents. However, the breakdown of the interments differed depending on which year we began to analyze the

data. For instance, the percent of cremations from 1899 to 2000 averaged 12%. However, from 1990 to 2000 the percent of cremations tripled averaging 36%. After determining the entry rates and distributions into the cemetery, we developed a model using these rates and distributions, which represented the cemetery process and forecasted the saturation rate. Before completing the model, the entry rates and distributions were verified using the Chi Squared test. After the model was developed, it was verified by running 30 simulations and comparing the forecasted output to the actual historical data from 1965 to 2000. With a verified and accurate model in place, we were determined the saturation rate of the cemetery: There is a 66% chance that Full Body Plots will be saturated by 2010 or sooner, and there is a 55% chance that Cremation Plots will be saturated by 2025 or sooner. After the development of different alternatives, this model was used to determine how each alternative would prolong the useful life of the cemetery.

### **3. Recommendation**

The team determined that the best alternative and final recommendation is a combination of several alternatives. This alternative consists of removing the hedgerow in Section XXX and expanding into the old PX parking lot and gas station area as well as the vacant areas beside and behind the PX, expanding Sections X and XI, using the area along the cemetery driveway for cremation plots, and constructing the retention wall along Washington Road to hold inurnments. This alternative would extend the useful life of the cemetery for full body and cremation burials by 63.5 years and 255.5 years respectively. The total cost of this recommendation is \$717,973.00.

In contrast, the current expansion plans that are approved and awaiting funding for the cemetery would extend the life of the cemetery by 18 years for cremations and 9 years for full body burials at a cost of \$3.37 million. Our recommendation would extend the life of the cemetery 7 times as long for full body burials and 14 times as long for cremations while saving the Academy over \$2.65 million.

#### **Presentations and Publications:**

- Capstone Project Day Briefings, May 2002
- MORS Presentation, June 2002

#### **Personnel Briefed:**

- Mr. John Mandia, numerous IPRs and Briefings throughout the academic year.
- Mr. Walter W. Hollis, May 2002.

**Status:** Complete. This team was designated as the winner of the 2002 “Hollis Award” as the best OR/SA cadet analysis for AY02.

*The final capstone report and briefings are filed with COL Carlton.*

## **EINSTEin Model Validation**

**Client Organization:** Deputy Undersecretary of the Army for Operations Research

**Principal Analyst:** MAJ Randall R. Klingaman, M.S.  
**Senior Investigator:** COL William B. Carlton, P.E., Ph.D.

### **Points of Contact:**

NAME:	ADDRESS:	PHONE:	OTHER:
Ms. Walter Holliis	D/USA OR	(703) 695-0083	

### **Problem Statement:**

The use of EINSTEin (Enhanced ISAAC Neural Simulation Tool) as a simulation model for self-organized emergent behaviors in combat is gaining widespread approval across the Operations Research community of both the Marine Corps and now the Army. This project will attempt to investigate a way to validate EINSTEin by comparing it against another well-known, accepted, valid combat simulation model, JANUS.

### **Scope of Work & Methodology:**

A faculty member will execute a design of experiments to attempt to “validate” EINSTEin as a combat simulation model. The basis of the experiment is to first establish the combat effectiveness of entities executing a National Training Center (NTC)-type scenario. The entities themselves will consist an unlearned set of entities and a set that have gained knowledge, or learning, through the use of a genetic algorithm incorporated in EINSTEin. The actions of these two sets of entities will then be programmed into JANUS and the combat effectiveness of each set will be compared against those obtained by using EINSTEin. Additionally, the scenario will be designed to replicate an armored company, 14 M1A1s, versus a similar size force of aggressors, 14 T-80 main battle tanks. Follow on scenarios may include a mixed force of M1A1s and M2 Bradley Fighting Vehicles against a mixed force of T-80s and BMPs, as well as a larger force structure.

The hypothesis of the experiment is that the learned set of entities will have a better loss-exchange ratio in EINSTEin and that the JANUS results will correlate with the EINSTEin results. The experiment will consist of a  $2^2$  experimental design, with the two factors being the simulation model, EINSTEin and JANUS, and the level of experience of the entities, learned and unlearned. The initial response variable is the loss-exchange ratio, representing the combat effectiveness.

### **Results Summary:**

The design of experiments centered on a  $2^2$  factorial experiment. The two factors were the agent type, and the model, either JANUS or EINSTEin. JANUS does not have a

genetic algorithm, so the agent types that were used to generate the data were classified as either an agent without learning or an agent with learning, who had gained “knowledge” via the genetic algorithm. We generated data using the EINSTEIN model first, and then input the formations, routes, and timing of the agents into JANUS and compared the Loss Exchange Ratio (LER) for each scenario. Our hypothesis is that the LER of the agents without learning and agents with learning in the agent based model, EINSTEIN, will follow similar outcomes when transferred to a traditional combat simulation model, JANUS.

The first step in the experiment was to convert the NTC terrain into a suitable terrain model into EINSTEIN. Next we addressed each of the applicable parameters within EINSTEIN to try to match the capabilities of both the M-1 and T-80. For example, the communications range of the EINSTEIN agents was set to the applicable range in EINSTEIN maneuver spaces to match the capabilities of the SINCGARS radio. The relevant parameters were set so that both the agents and the JANUS entities would have matching capabilities in maneuver speed, communications range, sensor range, and engagement capabilities. We then established the scenario to replicate 14 M1A1s against 14 T80s in a movement to contact mission using the “NTC” terrain. A total of 300 runs were used to generate LER data for the “unlearned” agents in EINSTEIN. Then we executed the genetic algorithm in EINSTEIN to allow the agents to alter their behavior and formations to best achieve the mission of maximizing the number of enemy killed and maximize the friendly-to-enemy survival ratio. A total of 300 runs were then used to generate another set of LER data with the new learned agent behavior and formations. Also, we were able to capture the center-of-mass positions of the agents to derive the routes we would input into JANUS.

We concluded that the agents with learning exhibit different behavior by: using terrain to their advantage; approaching the enemy more cautiously; moving and fighting in tighter formations; and retreating if significantly outnumbered or wounded. We also discovered that the mean LER of the EINSTEIN agents were statistically the same, despite our initial expectation that the LER would significantly increase when we used the genetic algorithm.

Our focus then turned to the JANUS model where we again created the scenario of 14 M1A1s against 14 T80s in a movement to contact mission. The JANUS terrain file we used was number 951. In order to keep similarity between the two models, we only modeled the main gun system on each tank, and not supporting weapon systems. Also, we used the Probability (Hit) and Probability (Kill) tables from the Joint Conflict and Tactical Simulation (JCATS) program to populate our JANUS tables for each tank. We derived the routes and the formations of each of the forces from the observed agent behavior in EINSTEIN. No other battlefield effects, such as artillery or smoke, were modeled on JANUS. A total of 30 replications of each route and formation were used to generate mean LER data sets.

Similar to the EINSTEIN results, we concluded that the mean LER of the JANUS agents without learning were statistically similar to the JANUS agents with learning. However, the JANUS agents did exhibit a much higher LER than the EINSTEIN agents. Using MINITAB to conduct a General Linear Model analysis of two factors with two levels indicated that only the model type effects LER outcome. We also noted that, despite a

lack of a greater mean LER when applying the genetic algorithm, the agents with learning did produce less standard deviation in the LER results.

Our most important outcome of the experiment is the modeling issues that we discovered when using both models and when transferring scenarios between the models. The agent based model suffers from a lack of elevation in the terrain and the inability to model roads and trails due to scalability. The probability of a hit in EINSTEIN is based on a single value and does not accurately reflect the Probability (Hit), Probability (Kill), engagement posture, and range of JANUS. The agent based model also does not model rates of fire, ammunition loads, other battlefield effects, or multiple weapons systems on a single platform. JANUS does not allow for information sharing among the combatants and does allow for a decision-making capability unless you introduce a human-in-the-loop. Similarly, combatant actions are not driven and/or altered by a mission objective; the routes, formations, weapons orientation are all pre-set, and hence, due not allow for an adjustment to achieve the mission.

We concluded that we fail to accept our null hypothesis. The LER is based only on the model type and was not affected by the agent type. We also were able to conclude that EINSTEIN does reasonably portray similarities of combat vehicles. Most importantly, "learning," as portrayed in an agent based model, can be transferred into a traditional combat model.

#### **Presentations and Publications:**

- Klingaman, Randall R. Presentation at the Military Operations Research Society, Working Group 29 (Modeling, Simulation, and Wargaming): *EINSTEIN Model Validation*, Ft. Leavenworth, Kansas, June, 2002
- Klingaman, Randall R. DSE Technical Report: *EINSTEIN Model Validation*, August 2002

**Status:** Paper forthcoming.

# **Information Overload at the Tactical Level (an application of Agent Based Modeling and Complexity Theory in Combat Modeling)**

**Principal Analyst:** MAJ David M. Sanders, M.S.  
**Senior Investigator:** COL William B. Carlton, P. E., Ph.D.

## **Problem Statement:**

This paper explores the ability of an Agent Based Model (ABM) in a Complex Adaptive Systems (CAS) environment to replicate the effects of information overload at the small unit tactical level. Information overload occurs in combat when a decision maker receives too much information to process adequately in the time allotted, however our current ability to replicate that in a combat simulation is limited. In this paper we examine the capability of Agent Based Models to identify and measure the effects of information overload.

Previous attempts to examine the effects of information availability in combat simulations has only been done by scrutinizing the actions of the simulation participants—by analyzing whether or not they were able to identify crucial information and then act on that information by implementing changes in the simulated units actions. This human-in-the-loop analysis has provided important insights into the use and availability of information, and has even suggested changes to doctrine [Barris], but is critically dependent upon the ability of the human – and not all humans are created equally in their ability to process and filter information.

## **Scope of Work & Methodology:**

We address the appropriate level of information availability in a tactical setting at the small unit level. We examine this issue through a simulation utilizing Agent Based Modeling in a Complex Adaptive Systems Environment. The ‘information level’ we address is a function of communication range, sensor range, and agent location. By varying the communication capabilities (range) we effectively vary the information available for use by an individual agent in decision-making. We examine the effect of this varying information level on the combat outcome of the unit with a metric of a Loss Exchange Ratio.

## **Results Summary:**

Our initial results show that there is a significant relationship in terms of combat outcomes that exists between the range of the sensor and the range of the individual soldiers communications capabilities. If our communications capability outdistances our sensors we achieve a greater advantage in battle, and as the communications capabilities increase past this range we see an additional increase in our combat outcome - but only to a certain point - at which time the combat outcome deteriorates. In addition, through a 2 variable landscape analysis of fitness profiles we conjecture that the ‘optimal’

information level is actually a dynamic quantity determined in some part by what phase of battle a unit is operating in.

**Presentations and Publications:**

- Sanders, David M. and Carlton, William B. *Information Overload at the Tactical Level*. Proceedings of the Society for Computer Simulation's Advanced Simulation Technology Conference, April 2002
- Sanders, David M. and Carlton, William B. *Information Overload at the Tactical Level*. Presented at the Society for Computer Simulation's Advanced Simulation Technology Conference, April 2002
- Sanders, David M. and Carlton, William B. *Evaluating Information Usage*. Presented at the 70th MORSS Symposium, June 2002.

**Personnel Briefed:**

- Conference participants

**Status:** Complete.

# **Modeling the Decision Quality in Sensor-to-Shooter (STS) Networks for Unattended Ground Sensor Clusters**

**Senior Investigator:** Dr. Patrick J. Driscoll, Ph.D.  
**Co-Investigator:** Lt. Col. Edward Pohl, Ph.D.

## **Problem Statement:**

Successfully transforming the U.S. Army into an Objective Force for the 21st Century requires new ways of thinking about the resources at the Army's disposal to create such a force: time, manpower and equipment. These assets must uniquely combine to not only afford future commanders a level of battlespace situational awareness far beyond that of our adversaries, but to equip our commanders with systems capable of near instantaneous reaction to enemy presence. One of the most promising concepts consistent with this design philosophy is an automated Sensor-to-Shooter (STS) network. An STS network is a closed-loop, internal feedback system that links various suites of sensors deployed throughout the 3D battlespace to a network of weapons platforms using optimized communications pathways. A fully-automated STS network can be decomposed into three major segments: target acquisition, a fires commitment decision process, and a weapons engagement process. Targets would be detected, classified and identified through the sensor end of the network. A decision support system would then determine if threshold criteria for target identification has been met, and if so, make the decision to commit the appropriate available weapons platform to engage the target. Once handed the fire mission, the weapons platform would engage the target, the sensors would assess the damage, the decision support system would again compare target damage to threshold criteria, and re-engage as necessary. Doing this successfully is tricky business, especially in general support of operational forces. Understanding the quality of the information upon which the two critical decision processes draw is a fundamental requirement for building trust in such a system.

In this study, we propose a method of assessing the decision quality of a sensor-to-shooter (STS) network that draws on ideas normally resident in the domain of information quality and combines them with several notions from the domain of operations research. We combine these ideas to create a framework capable of yielding stochastic sensitivity information concerning the processes and devices of the network. Our motivation in all this is to answer the decision quality question in terms of the amount of uncertainty present in the information product used to make the fire/no fire decision. The results of this sensitivity can be directly used to identify an information quality critical path and to design a system with a high quality information product at the decision point. Moreover, this approach provides insights into where the most effective quality enhancements should be performed and whether or not continued effort to improve sensor device precision is warranted.

## **Scope of Work & Methodology:**

Research the decision quality associated with sensor-to-shooter (STS) networks for use by the Objective Force FCS. The following questions represent a subset of those we seek to resolve through this study:

- Where are the key locations in an STS network and what levels of information uncertainty exist at these key points?
- What are the sources of this uncertainty?
- What levels of information uncertainty should exist in an STS network?
- How do these levels of uncertainty compare with those encountered in the existing platform-centric shooter systems?
- What quality efforts (if any) can be taken to reduce the level of information uncertainty and increase the stability of information in an STS network?
- Where should these quality efforts be applied?
- Are there points of diminishing returns related to maintaining information quality in an STS network?
- What effect do increases in network device precision have on the decision quality of an STS network?
- What guidance can be provided for future TOE design?

The following methodology will be employed in the continuation of this study:

1. Develop exact closed form analytical expressions for the marginal contributions to uncertainty made by each of the processes and devices of an UGS-based STS network using the recursive backtracking method of Ballou & Pazer (1985).
2. Develop closed form analytical expressions for the distributions associated with the cluster report information product, the master node identification process, the hub COP information product, and the final information product present at the decision point(s).
3. Analyze the sensitivity of various statistical parameters describing the decision point distribution (the uncertainty involved with the decision point) to changes in number of sensors, mix of sensors, and precision levels of sensor functions.
4. Identify an information quality critical path through the UGS-based STS network leading to a prioritized information maintenance schedule.
5. Integrate the sensitivity results with the sensor performance tradeoff function results obtained by Lamm and Driscoll (2002) in order to propose equivalence measures and points of diminishing returns with regards to device precision and response levels of uncertainty.

6. State the implications for future research and development on sensor precision and quantify the marginal benefits of performing specific information maintenance actions at various locations throughout the network. We additionally provide guidelines as to the goals that such activities should seek.
7. Create a Raptor or MODSAF simulation to compare the analytical results obtained to numerical results in the simulation environment. Perform standard data analysis to identify critical factors affecting design issues. It is at this stage that we propose to validate our results with the performance statistics of actual sensor clusters at the Night Vision Laboratory's test center.
8. Using the framework developed in (1)-(7) above, apply the same methodology to each homogeneous sensor cluster type in succession: acoustic, seismic, thermal (IR).
9. Modify the simulation to include the effects of uncertainty associated with weather and terrain, and perform a sensitivity analysis on the decision quality in context of these effects.
10. Examine the feasible combinations of sensor types in an  $n$ -sensor cluster environment as to their effect on the decision quality at the fire/no fire point of the STS network in order to identify high performance combinations of sensor types that simultaneously minimize the amount of uncertainty present at the decision point. The results of this effort will be used to prescribe TOE and general sensor cluster composition guidelines based on decision quality.
11. Design and conduct a command post simulation workshop at West Point that will illuminate issues associated with deploying STS networks on the battlefield. Such issues include gaining a quantitative understanding of the level of operational range of uncertainty that commanders are presently making effective decisions within.
12. Integrate the results of (1)-(12) into the joint STS network environment.

### **Results Summary:**

In AY02, we first developed a new representation of a general support STS network within an information manufacturing framework based in part on the taxonomy of uncertainty introduced by Smets (1991, 1997) and the information quality decomposition of Eppler (2001) and Wang (2001).

Using this framework, we defined the decision quality of an STS network based on the uncertainty present in the final information product associated with the fire/no fire decision point independent of the actual decision made, thereby uncoupling process outcome from action outcome. This definition of decision quality then allowed us to define a conceptual uncertainty network flow that isolates the total contribution to uncertainty made by the individual devices and processes associated with an STS network.

Moreover, we introduced a methodology for obtaining closed form expressions for the marginal contribution each device and process contributes to the overall uncertainty.

This methodology, coupled with the framework noted, clearly illustrates how a stochastic sensitivity analysis can be performed and how such a sensitivity analysis reveals the data needed for identifying an information quality critical path through the network. This path then defines a prioritization of information maintenance tasks needed to enhance and maintain the decision quality of an STS network.

**Presentations and Publications:**

- Driscoll, P.J. & E. Pohl. Presentation at the 70<sup>th</sup> Military Operations Research Society, Information Operations Working Group *Modeling Decision Quality of Sensor-to-Shooter (STS) Networks*, Fort Leavenworth, Kansas, June, 2002.
- Driscoll, P.J., and E. Pohl. Accepted for presentation at the International Conference on Information Quality (ICIQ), MIT, Cambridge, Massachusetts, November, 2002.

**Status:** This is a multi-year, continuing project.

## **Networked Ground Micro-Sensors**

**Client Organization:** US Army Research Laboratory (USARL) and CECOM Night Vision (NVESD)

**Principal Analysts:** CPT Linda M. J. Lamm, M.S., MAJ Gregory A. Lamm, M.S.  
**Senior Investigator:** Dr. Patrick J. Driscoll, Ph.D.

### **Points of Contact:**

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Jerome Gerber	ARL Attn: AMSRL-SE-SA 2800 Powder Mill Rd Adelphi, MD 20783	DSN 290-2624 (301)394-2624	Jgerber@arl.army.mil
Douglas Paul	NVESD, C4I/Modeling Simulation Bldg 309 10221 Burke Rd Ft Belvoir, VA 22060	(703) 704-2070	Douglas.paul@nvl.army.mil

### **Problem Statement:**

Deciding whether or not it makes sense to substitute UGS for human force elements requires an understanding of the functional tradeoff relationships that exist between these elements, the levels at which equivalence is achieved, and the human response in the context of battlespace operations to having made such a replacement. Providing a quantitative response to these requirements is the focus of this study. Our goal is to exploit the resulting information in order to provide design guidance concerning both the effective deployment levels of UGS on the battlefield and practical levels of TOE assignment for these devices.

The objectives of this study are six-fold:

1. Introduce key functional tradeoffs that exist between the number of sensors and performance metrics in BLOS and NLOS deployment for clusters of homogeneous UGS types;
2. Validate the tradeoff relationships by comparing them against the results of a simulation experiment conducted at Fort Knox, Kentucky in April 2002 called the Future Combat Command and Control 2 Simulation Exercise (FCC2);
3. Identify points of diminishing returns for each sensor performance measure that can subsequently support an optimization of these measures using multi-objective tradeoff analysis;

4. Identify equivalence points between personnel and sensor clusters within the context of the typical mission set (intelligence) for the RSTA squadron;
5. Prescribe ideal deployment levels and TOE assignment levels for general force configuration guidelines;
6. Provide a foundation for continued research examining the information flow on an UGS-supported sensor-to-shooter (STS) network as it relates to sensor mix and decision quality issues.

### **Scope of Work & Methodology:**

UGS have the potential to not simply augment current operational capabilities, but to actually replace elements in the Objective Force whose battlespace functions can be more effectively performed by UGS. In this manner, sensor technologies can change the way the Army does business, potentially change its operational art, and certainly change the way the Army forces are configured for battle. For example, some scout functions in support of target acquisition by the Reconnaissance, Surveillance, Targeting and Acquisition (RSTA) squadron might be performed at higher precision, lower risk, and longer duration by UGS.

Deciding whether or not it makes sense to substitute UGS for human force elements requires an understanding of the functional tradeoff relationships that exist between these elements, the levels at which equivalence is achieved, and the human response in the context of battlespace operations to having made such a replacement. Providing a quantitative response to these requirements is the focus of this study. Our goal is to exploit the resulting information in order to provide design guidance concerning both the effective deployment levels of UGS on the battlefield and practical levels of TOE assignment for these devices.

### **Results Summary:**

Providing a methodology for future researchers and developers concerned with the deployment levels and use of Networked Unattended Ground Sensors is a valuable contribution to the Future Combat System of Systems team and anyone else concerned with the use of UGS on the battlefield. We outlined a number of other researchers and their work relating to this paper, provided an introduction and information on the different UGS types and their strengths and weakness, presented a number of tradeoff relationship ideas and showed the process for validating them and finding the points of diminishing returns for each tradeoff relationship. We also presented a process for validating the tradeoff relationships by laying out the requirements for a sensor simulation program to answer all of the necessary fact finding questions necessary to perform the tradeoffs we discuss.

Understanding the relationships and points of diminishing returns helps decision-makers resource UGS deployment densities and costs. This understanding also assists researchers in improving the UGS system and sensor cluster performances. It is essential that we understand the interdependencies and interconnectedness of the UGS systems, and we recommend a methodology be used to do that. A likely methodology is the one

presented in this paper as a way to systematic problem solving for all FCS type applications.

**Presentations and Publications:**

- Lamm, Linda, M.J., Gregory A. Lamm, and Patrick Driscoll. *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology*. Technical Report, Department of Systems Engineering, United States Military Academy, West Point, NY, June 2002.
- Lamm, Linda M.J. Presentation at the Military Operations Research Society, Working Group 10 (Unattended Systems): *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology*, Fort Leavenworth, Kansas, June 2002

**Personnel Briefed:** None

**Status:** Complete.

## **Enhanced Use Leasing**

**Client Organization:** The Assistant Secretary of the Army for Financial Management and Comptroller – ASA (FM&C)

**Principal Analyst:** MAJ Sandra L. Vann-Olejasz, M.B.A.  
**Senior Investigator:** COL William K. Klimack, Ph.D.

### **Points of Contact:**

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### **Problem Statement:**

The Department of the Army has identified real property that is either excess or underutilized. Once a federal government agency deems property excess, the GSA is responsible for disposing of the property according to the Federal Property and Administrative Services Act of 1949 and other Federal Property Management Regulations. Recent legislative changes have also enhanced the authority of military departments to lease non-excess property. Any revenues derived from the sale or lease of Army property goes back to the Army. As with any underutilized or excess inventory, the goal should be to either look for new ways to gain value from the inventory, or expeditiously dispose of it. In either case, the Army should consider ways to make financially beneficial decisions with regard to its property without degrading any mission needs. This study focuses on products to assist the installation commander in implementing the enhanced use lease process. Specifically this report proposes sequenced process guidance that assists installation commanders in implementing enhanced use leasing and proposes a tool to aid installation commanders in the selection of qualified developers.

### **Scope of Work & Methodology:**

Research the legislative and regulatory requirements for military real estate actions, current processes, and real estate market factors. Considering these points, develop and document a process methodology focused on the perspective and needs of the installation commander. In addition, develop a selection tool to assist in guiding installation commanders in choosing an enhanced use leasing development partner.

- Perform an extensive literature review and develop an expert understanding of the existing programs, laws, directives, and procedures involved in the identification and disposition of real property deemed excess or underutilized.
- Establish and document an enhanced use lease process visual management tool that incorporates usable information for an implementing agency.
- Develop an EUL partner selection tool that can be tailored to unique projects and/or installations. The tool should include recommended measurements to guide the installation commander and members of the selection panel in the selection process.

### **Results Summary:**

Section 2667, the legislative authority for enhanced use leasing, has been in existence for decades, but the legislation was restrictive in its application and was not viewed as a potential tool to offset base operating costs. The enhancements to the legislation combined with the military movement to seek better business practices, led to a drive to increase the number of enhanced use lease projects.

This report identifies the process steps of an enhanced use lease and, in order to articulate the process in a fashion that adds value to the user, we looked for other information that would be useful to be displayed in the same area. In order to do this, we used a common package to all installations and staffs, Microsoft Excel. Packaging the EUL process in this fashion provides the visual benefit of a flow diagram, a searchable field structure, as well as the ability to quickly add, delete, or modify steps. This product can also be easily tailored to each installation or project if necessary. Another primary feature of this tool is that it provides a quick reference to several categories, to include:

Action, Responsibility, Coordinating/Supporting Agencies, References/Regulations, Areas to Consider/Lessons Learned, and Potential Risks. By adding these categories, users can figure out who is responsible for each step, who the approving authorities are, as well as be made aware of potential risks. This will help streamline the process and assist in risk management.

Using the Fort Sam Houston Beach Pavilion enhanced use lease project as a benchmark, we streamlined and documented the developer selection process in the form of a tailorable Microsoft Excel tool. This report details the suggested composition of the developer selection committee and establishes measurable criteria from which to recommend the best developer to the installation commander. Topics for further research, to include the validation of the tools based on proposed EUL projects are suggested in this report.

### **Presentations and Publications:**

- Vann-Olejasz, Sandra L., MAJ DSE Technical Report: *Enhanced Use Leasing*, July 2002

- Vann-Olejasz, Sandra L., Degrazio, Barry, and Kitzman, Tara. Presentation at the University of Virginia Capstone Conference: *Enhanced Use Leasing, How to Select the Best Developer*, April 2002

**Personnel Briefed:**

- Mrs. Sharon Weinhold (Principal Deputy – ASA(FM&C) and Mr. Alan King (Deputy Garrison Commander, Walter Reed Army Medical Center) *IPR and Interim Analysis of Process Steps* – 13 Nov 2001
- Mr. Erich Kurre (ACSIM) *Process Timelines* – January 2002
- Mrs. Sharon Weinhold, and Mrs. Deb Ramirez (ASA(FM&C), Mr. Bill Johnsen (ACSIM) *IPR and Process References* – 5 February 2002
- Mrs. Deb Ramirez, and Mrs. Mary Engoglia (ASA(FM&C), Mr. Bill Johnsen (ACSIM) *Developer Selection* – 8 May 2002
- Mrs. Sharon Weinhold, and Mrs. Mary Engoglia (ASA(FM&C), Mr. Bill Johnsen (ACSIM) *Final Products and Outbrief* – 28 June 2002

**Status:** Complete.

# **Global Combat Service Support System – Army Analytic Support**

**Client Organization:** Program Manager Global Combat Service Support System – Army

**Senior Investigator and Principle Analyst:** COL William K. Klimack, Ph.D.  
**Supporting Analysts:** MAJ Sandra Vann-Olejasz, M.B.A., CPT Frank J. Snyder, M.S.

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## **Problem Statement:**

Assist the evaluation of alternatives for the Global Combat Support System – Army information technology system.

## **Problem Description:**

The Global Combat Support System – Army (GCSS-A) is an information technology (IT) system to be fielded to replace all current Army tactical logistical and administrative IT systems. It has been proposed that an Enterprise Resource Planning (ERP) IT solution be employed for GCSS-A. Such an implementation is innovative for numerous reasons, and offers potential for greatly increased efficiency and cost savings. It does increase significantly the technological risk of successful implementation, as it would require unique technological solutions to operate in the austere tactical data communications environment.

The Program Manager Global Combat Service Support System – Army (PM GCSS-A) initially requested Operations Research Center of Excellence (ORCEN) assistance in an underway evaluation effort conducted through a contractor. The ORCEN reviewed the evaluation plan and observed user jury portions of the evaluation.

After a decision to conduct an abbreviated Analysis of Alternatives (AoA), PM GCSS-A requested that the ORCEN assist Combined Arms Support Command (CASCOM) in an

evaluation of GCSS-A alternatives. The AoA alternatives were a commercial off-the-shelf (COTS) ERP for GCSS-A or continued pursuit of traditional software development

### **Summary:**

The observations of the initial evaluation phase provided an assessment of the process as well as recommended improvements. Specific restructuring of the criteria provided improved communication for the decision maker and facilitated analysis. Implicit assumptions contained within the evaluation were articulated and their impact assessed.

When the abbreviated AoA was proposed, the ORCEN recommended that a decision analysis (DA) approach be adopted with decomposition of the decision aspects into three major components: cost, performance, and schedule. This was accepted in principle, but time constraints prevented full implementation of the DA methodology by CASCOM.

The decision situation was decomposed into the three major components of cost, performance, and schedule. A contractor under the direction of the PM GCSS-A prepared the cost data. The office of the PM GCSS-A prepared the schedule information. CASCOM established performance criteria based on the Operational Requirements Document, and solicited input of subject matter experts (SMEs) regarding relative (ordinal) importance of the criteria. With CASCOM approval, the ORCEN improved the SME feedback by eliciting additional information to provide cardinality in the ratings.

Decision analysis was employed by the ORCEN to extend the CASCOM analysis. To implement a DA model of the decision situation, the ORCEN elicited performance ratings and value functions from logistics subject matter experts assigned to the United States Military Academy faculty. A decision analysis model was based upon, and complementary to, the CASCOM work. The DA model was used to provide a recommendation regarding the optimal alternative for GCSS-A. The recommended decision is estimated to save \$27 million over the life of the system and nine months time in implementation. Besides the alternative recommendation, other recommendations were provided to assist in implementation execution. These recommendations were determined from interviews of IT SMEs in the private sector.

### **Presentations and Publications:**

- Klimack, William K., Sandra L. Vann-Olejasz, and Frank J. Snyder. "Decision Analysis Support for the Global Combat Service Support System – Army," Fort Leavenworth, Kansas: Presentation at 70th MORSS, 18 June 2002.
- Klimack, William K. "Executive Summary: ERP (Build) vs. ERP (Commercial) Decision." Operations Research Center of Excellence, Department of Systems Engineering, United States Military Academy, 3 October 2002.
- Klimack, William K., Sandra L. Vann-Olejasz, and Frank J. Snyder. *GCSS-A Alternative Evaluation*. Operations Research Center of Excellence Technical Report TR-02-01. West Point: USMA, May 2002.
- Klimack, William K. "Summary of Observations During SAP Demonstration for GCSS-A User Jury, 7 November 2001." Memorandum Report Number MR-02-

01. Operations Research Center of Excellence, Department of Systems  
Engineering, United States Military Academy, 8 November 2001.

**Status:** Completed

# A Hybrid Value-Utility Approach for Military Decision Analysis

**Client Organization:** USMA / Department of Systems Engineering

**Principle Analyst:** COL William K. Klimack, Ph.D.

**Senior Investigators:** Prof. Jack M. Kloeber, Jr., Ph.D.,  
Prof Kenneth M. Bauer, Jr., Ph.D., and Prof Mark Oxley, Ph.D.,  
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## Problem Statement:

Complex, uncertain problems analyzed under Multiattribute Utility Theory (MAUT) in Decision Analysis (DA) employ utility functions that impose a time burden on senior decision makers. Value functions may be prepared by staff and subject matter experts, reducing this burden, but are not theoretically appropriate. Using value functions and selected utility functions, a hybrid value-utility model may be developed that performs well enough to serve as a surrogate utility model. The advantage is the reduced elicitation burden encourages employment of MAUT DA to solve difficult problems.

## Scope of Work & Methodology:

Decision Analysis (DA) uses preference functions to model decision situations. Under certainty, these functions are referred to as value functions and are identified as utility functions under uncertainty or risk. Value functions reflect the decision maker's strength of preference information. Utility functions include strength of preference information as well as incorporating the decision maker's risk attitudes. These risk attitudes make the utility function unique to each individual, while a set of value functions may be elicited from subject matter experts (staff officers, for example) or developed through a concurrence of groups of individuals. As most decision situations involve uncertainty, a utility model is appropriate, but imposes a great time burden on the decision maker for large problems. The ability to reduce the elicitation burden imposed upon a decision maker such as a commanding general or program executive officer is highly desirable.

The literature varies widely in opinion regarding the relationship between value and utility functions. The research will initially investigate this relationship employing multivariate empirical data, an extension to previous single dimensional studies. The data will also be unique, as it will pertain to military decision making, where criteria markedly differ from traditional DA studies. The second phase will be to develop a hybrid value-utility model and an employment algorithm. The intent is to provide methodology for large, complex, uncertain problems that facilitates employment of the DA approach while minimizing the elicitation burden on the decision maker.

The research had two major objectives, both pertaining to the relationship of value and utility preference functions in decision analysis. The first was to examine this relationship itself between value and utility functions. Possible relationships between the functions, each with underlying theoretical implications, were examined. Clarification of the relationships provides insight into risk attitudes as well as facilitates representation of empirical data with functional forms. The second was to improve the efficiency of decision analysis by determining when the distinctions between value and utility preference functions were significant, and exploiting the situation when they are not to increase elicitation efficiency.

### **Summary:**

This work is the first to enter the literature regarding comparison of value and utility functions for decision analysis examining multidimensional data from military professionals as subjects. This research supports the hypothesis that single dimensional value and utility functions are not equivalent. This conclusion was confirmed for two separate military decision making situations. An improved measure of differences between preference functions, WRMSE, was created. Acceptance criteria for adequate model fit, based on elicitation error, were established for WRMSE and RMSE

No single functional relationship defined the relationship between value and utility functions. The relationships between value and utility functions for multidimensional military decisions were found to be complex. New metrics were developed that improved the ability to assess the risk attitudes of decision makers. Risk attitudes were generally neither constant across the domain of the evaluation measure, which is not consistent with most assumptions, nor consistent between evaluation measures. Certainty equivalent and probability equivalent elicitation methodologies provided equivalent results. Value and utility functions differed significantly more than can be explained by elicitation error. Aggregating single dimensional utilities into a multiattribute model and the multiattribute utility produce results that are not strategically equivalent.

The sensitivity of decision analysis models to perturbation of the preference functions was examined. This involved the first use of response surface methodology (RSM) on preference functions and the research demonstrated that response surface methodology may be successfully applied to preference functions. This permits construction of a hybrid value-utility model that facilitates more efficient elicitation of information from the decision maker.

The concept of a hybrid value-utility decision analysis model was first advanced in this work. An algorithm was created that was successful in providing the hybrid model. The hybrid multiattribute utility model provided an adequate representation of the true multiattribute utility model. Elicitation of the hybrid utility model is more efficient with respect to decision maker participation than employing the strict utility model, especially in cases where there are a large number of evaluation measures or cases where several of the measures require an inordinate amount of time to elicit additional utility information. Such efficiency promotes use of decision analysis and encourages sound decision-making.

Such a model may be constructed beginning with a value model based on elicitations from subject matter experts, e.g., staff officers. Selected single dimensional value

functions are replaced with the corresponding utility functions to form a hybrid model. Substitutions are prioritized through response surface methodology applied to the value functions of the decision model. Substitutions continue until the performance of the hybrid suitably estimates the performance of the true utility model. Construction of such a hybrid model minimizes the burden placed on the decision maker while maintaining the benefits of DA. A sample case illustrates the elicitation efficiency where an automatic target recognition classification system choice attribute set was reduced from 23 to significant eight evaluation measures. Elicitation of utility functions for the eight measures provided a hybrid model that adequately represented the true utility model, yet was more acceptable to the decision maker.

While value and utility are differing constructs, prudent exploitation of their differences and similarities permits more efficient use of the decision maker's time. This work emphasizes that the distinction between value and utility must not be ignored. However, the lack of strategic differences for specific cases may be identified and exploited. The implementation of the hybrid value-utility methodology is promulgated in the technical report.

#### **Presentations and Publications:**

- Bassham, C. Brian, William K. Klimack, and Kenneth W. Bauer, Jr. "ATR Evaluation Through the Synthesis of Multiple Performance Measures," *Signal Processing, Sensor Fusion, and Target Recognition XI*, Ivan Kadar, editor. Proceedings of SPIE volume 4729. Bellingham, Washington: The International Society for Optical Engineering, April 2002.
- Klimack, William K., Christopher B. Bassham, and Kenneth W. Bauer, Jr. *Application of Decision Analysis to Automatic Target Recognition Programmatic Decisions*. Technical Report AFIT/EN-TR-02-01. DTIC ADA401738. Wright-Patterson Air Force Base: Air Force Institute of Technology, October 2001.
- Klimack, William K., C. Brian Bassham, and Kenneth W. Bauer, Jr. "ATR Evaluation Through the Synthesis of Multiple Performance Measures," Aerosense Conference, The International Society for Optical Engineering, Orlando, Florida, 1 April 2002.
- Klimack, William K., and Jack M. Kloeber, Jr. "Military Relative Risk Aversion," INFORMS Annual Conference, San Jose, California, scheduled for 18 November 2002.
- Klimack, William K. *Robustness of Multiple Objective Decision Analysis Functions*, Dissertation, Air Force Institute of Technology, Wright-Patterson Air Force Base, June 2002.
- Klimack, William K. "Robustness of Multiple Objective Decision Analysis Functions," Presentation, Air Force Institute of Technology, Wright-Patterson Air Force Base, 17 May 2002.

**Status:** Completed.

## **Unit Rotation Study**

**Client Organization:** Army G1

**Partner Organization:** Office of Economic and Manpower Analysis, Department of Social Sciences, United States Military Academy

**Senior Investigator and Principle Analyst:** LTC Michael Kwinn, Ph.D.

**Supporting Researchers:** COL William K. Klimack, Ph.D.; Dr. Bobbie L. Foote, Ph.D.; Lt. Col. Edward Pohl, Ph.D.; MAJ Dan McCarthy, M.S.; MAJ Sandra Vann-Olejasz, M.B.A.; MAJ Michael Nowatkowski, M.S.; MAJ Brian Layton, M.S.; and CPT Frank J. Snyder, M.S.

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### **Problem Statement:**

Evaluate the benefits and disadvantages of conducting a unit rotation personnel replacement system for the 2<sup>nd</sup> Infantry Division in the Republic of Korea.

### **Problem Description:**

The US Army employs an individually-based personnel replacement system to meet manning needs in tactical units. It was proposed that replacing that system with one that rotates units from the continental United States to overseas locations would increase unit cohesion while providing dollar cost savings. LTG LeMoyne, the Army G1, observed that an individual replacement system is easier to manage, but that he was willing to replace it with a unit replacement system if increased tactical unit effectiveness was achieved. In order to scope the problem to provide a tractable analytic problem, the Second Infantry Division (2ID) in the Republic of Korea (ROK) was selected as the study focus.

### **Scope of Work and Methodology:**

Systems engineering principles were applied to scope the problem and identify pertinent factors. Decision analysis was employed to evaluate the readiness of alternatives, employing the unit status report concepts of readiness. Simulation was employed to capture unit turbulence information. Assumptions required for tractability were captured.

### **Results Summary:**

The level of execution of a rotation policy was examined, considering the alternatives of rotating the entire division, brigades, brigade task forces, battalions, and battalion task forces. A value-focused decision analysis approach was used to consider input from a number of tactical subject matter experts. Rotations at the battalion level were determined to be the most advantageous for most units. For division troops-type units, rotation is preferred at the company level.

The majority of turnover within tactical units is due to separations, and therefore cannot be ameliorated with a unit rotation policy. Predeployment personnel turbulence suggests that there is no benefit for “fencing” units longer than 24 months under the current turbulence factors. Further, long fenced periods are constrained by the number of FORSCOM units available.

Unit rotations do provide substantial improvements in stability of personnel in small units in the 2ID over the current system. No attempt was made to assess the benefits of this improved stability in terms of combat power. Rotation periods of six months appear to be optimum for the total active Army.

Unit rotation transportation costs approximately equal the current PCS expenditures. Some savings could be achieved by not moving families as is currently done for soldiers PCSing to the ROK. Implementing a unit rotation plan would entail substantial investment in military construction to provide barracks, organizational buildings, motor pools, and other structures in the continental United States. Unit equipment sets would have to be purchased, assembled, and monitored to facilitate equipment handovers in Korea. Available unit sets in the Pacific region may be employed to provide the base of the majority of rotational units, but do not provide all equipment needs. Both these actions would also increase maintenance costs to provide for the additional infrastructure. These latter costs were not estimated, but appear likely to greatly exceed the savings accrued through elimination of family moves.

### **Presentations and Publications:**

- Technical Report in preparation.

### **Personnel Briefed:**

- LTG John M. LeMoine, Deputy Chief of Staff, G1, and MG Lawrence Adair, The Pentagon, 10 July 2002.

**Status:** Ongoing.

# **Development of Land Warrior Simulation Training Methodology**

**Client Organization:** Project Manager-Soldier Systems

**Principal Analyst:** MAJ Christopher M. Farrell, B. S.  
**Senior Investigator:** COL William K. Klimack, Ph.D.

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## **Problem Statement:**

The overall goal of this project is to study the use of embedded simulation in the Computer Based Training (CBT) methodology of PM-Soldier's Land Warrior combat system. Corollary research will investigate the merits of integrating Interactive Multimedia Instruction (IMI) and Advanced Distributed Learning (ADL) into the overall training framework of Land Warrior.

## **Scope of Work & Methodology:**

The preponderance of effort during the first year of this multiyear research project centered on two key areas. These were to examine the uses of CBT-IMI and simulation to train combat systems use and application in Army programs, and (2) document the historical use of PC-based simulations at the United States Military Academy (USMA). These goals were accomplished through attendance at professional conferences that focused on military applications of simulation technologies, personal interviews with experts in the field, and an extensive literature search. The following key tasks were addressed in this manner such that the researchers could supervise the development of IMI tailored specifically to military science education at USMA. This IMI would be employed during Military Intersession 2003 and its effectiveness evaluated through data

analysis of a predetermined task or set of tasks. Supporting activities include the following:

1. Determine the status of current initiatives and provide insights that focus on the integration of CBT and simulation into draft Land Warrior training plans and operational requirements documents for LW training devices.
2. Survey the existing body of knowledge for successful employment of CBT-IMI to other tested combat systems. Examine both military and civilian resources and gather empirical evidence that quantifies the overall effectiveness of CBT-IMI and ADL in education and training.
3. Evaluate soldier, leader and collective tasks to determine what type of simulation (Live, Virtual or Constructive) would elicit the most effective training results, using the Land Warrior system as a case study.
4. Develop a CBT-IMI methodology that may be used to supplement the existing System Training Plan (STRAP), produced by TRADOC, for Land Warrior. Create a software assessment methodology, to include definition of metrics and development of an evaluation framework, for military applications software that might be used in CBT for Land Warrior.

### **Results Summary:**

There are several initiatives that are being pursued concurrently with respect to Land Warrior. Developmental Testing (DT) is planned and awaiting execution at Aberdeen Proving Ground (APG), MD using soldiers from 1st Battalion, 325th Infantry (Airborne) from Ft. Bragg, NC. The Program of Instruction (POI) for Land Warrior training and maintenance courses, as well as Tactics, Techniques, and Procedures (TTPs) have largely been written and are under review/revision. Additionally, PM-Soldier and TRADOC Analysis Center (TRAC)-Monterey, CA are jointly researching software technologies for training Land Warrior. The original STRAP for Land Warrior was drafted in 1999 and did not incorporate CBT-IMI.

We envision embedded simulation, either organic to the combat system itself or, more likely, simulation included in courseware as a practical exercise, is a very useful tool that can be employed to effectively train those tasks that are best accomplished via CBT. The collective, leader, and individual tasks that support many mission essential task list (METL) tasks are probably best trained using CBT-IMI, due to the risk and/or costs associated with live-fire training. In terms of engaging cadets in the classroom during military science education, both at the service academies and in Cadet Command, simulation has shown to be a motivating alternative to the cadets.

Simulated collective practical exercises have been accomplished during Military Intersession over the past two years at USMA. Cadets and faculty members alike have voiced their collective approval in this method of achieving synthesis between the various topics taught in class and the application of combat power at the company level and below. Cadets have said that they prefer this method for a variety of reasons. Among these are our constantly improving ability to immerse them in a near-virtual environment, and allowing them to fight as the member of team, squad, or platoon to achieve a common military objective. Instructors like it because they can easily determine the

effectiveness of their respective sections' internalization of the lesson objectives and application of them in a collective (simulated) mission. Additionally, COTS games that have been employed during intersession have allowed instructors to replay the actions of their sections in simulated combat as an after action review (AAR) tool.

The researchers have provided input in several areas that have advanced this process at the Academy, as well as assisting PM-Soldier and Omega Training Group, the contractor responsible for developing LW training devices and doctrine. Among these initiatives were that feedback was provided to Novalogic, developer of Delta Force II, via TRAC-Monterey, so that the software could be made more doctrinally correct.

For the PM, feedback was provided on LW Leader/Operations Program of Instruction (POI), the LW STRAP for 2002, and ORDs for LW training devices. As one of six members of the LW IMI team, the principal researcher took part in LW IMI quality control and development. As a member of the LW Training Functional Working Group (TFWG), he attended Training Conferences #1 and #2 and the LW Analysis of Alternatives (AoA) at Ft. Benning, GA, as well as LW IPTs at Ft. Belvoir, VA. This gave us a forum within which to provide inputs on system evaluation and testing. USMA's efforts in virtual desktop simulation were spotlighted in a STRICOM Congressional M&S demonstration in February 2002, as well as at the Simulation Training Evaluation Periodic Review (STEPR) 02-1 at the National Simulation Center (NSC), Ft. Leavenworth, KS.

Recent initiatives at USMA have focused on developing an IMI pilot program that centers on the use of an enterprise course/learning management system (CMS/LMS) here. The academy was earmarked to receive assistance from the Joint ADL Colab in Orlando, FL as one of four colab-sponsored pilots.

The major contributions for Phase I of this project are that USMA has been portrayed in numerous venues among our sister services and NATO partners as a champion of ADL. We are attempting to further this initiative through the successful employment of e-learning in military science instruction. This includes furthering the use of simulation as an integral part of military science education at West Point. We have begun to build the infrastructure at USMA that allows continuous experimentation/data collection during cadet training. The vision for this was developed during AY02 and is being executed during the remainder of FY02 and will be continued during FY03. This included the integration of the CMS/LMS, which has already been selected. DMI's Warfighting Center (WARCEN) will be expanded through the upgrade of existing servers to support IMI and gaming/simulation on the web. USCC and O/Dean are partnering on the use of the Academy's numerous labs for experimentation during MI2003. Arguably the greatest contribution during this research year has been an adjustment in the institutional mindset at USMA: cadets and faculty members alike have come to anticipate simulation events as a means of conducting small unit collective training. Qualitative data has been collected and is being analyzed to determine the degree to which cadets value and perceive that PC-based simulations impact their learning.

#### **Presentations and Publications:**

- Farrell, Christopher M. ORCEN Technical Report: *Application of PC-based Games in Military Science Education and Training*, forthcoming.

**Personnel Briefed:**

- Dr. Randall W. Hill, Deputy Director of Technology, Institute for Creative Technologies, Marina del Rey, CA – August 2001.
- Dr. David Troxel, Deputy Project Manager, PM-Soldier – December 2001.
- Dr. Jan Chervenak, Director, Dismounted Battlespace Battle Lab, Ft. Benning, GA – January 2002.
- Mr. Ellis Mosely, Chief, R&D Logistics, RMD, PM-Soldier – March 2002.
- COL Theodore Johnson, Project Manager, PM-Soldier – May 2002.

**Status:** Phase I complete. Phases II and III to be completed during AY2003.

# Vulnerabilities Analysis of FCS Conceptual Design Alternatives

**Client Organization:** Program Manager, Objective Force

**Principal Analyst:** MAJ Patrick Magras, M.S., CPT Richard Richkowski, M.S.  
**Senior Investigator:** LTC Michael J. Kwinn, Jr., Ph.D., Lt Col Edward A. Pohl, Ph. D

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## Problem Statement:

FCS will face asymmetric threats and an adaptable and determined enemy. If the threat learns to exploit the vulnerability of the FCS over time due to our reliance on the networking to achieve mission success, FCS force survivability and effectiveness could be compromised or rendered helpless. History has many examples of inferior forces learning to exploit the weaknesses of their much larger adversaries to achieve mission success. The analysis will focus on the assessment and management of potential vulnerabilities in the Future Combat System concept, in general.

## Scope of Work & Methodology:

The Department of Systems Engineering will execute a yearlong research project on behalf of PM, FCS to conduct analysis on each of the four competing conceptual design alternatives to assess their individual vulnerabilities to non-standard threat profiles. This analysis will be conducted in two parts: one will be an objective, analytical approach and the other will be a subjective thought-analysis.

History is replete with anecdotal evidence of vastly overwhelming military forces being defeated and even completely destroyed by seemingly inferior forces. These inferior, and victorious, forces only advantage was their exploitation of a single vulnerability of the superior force. The Future Combat System is designed to provide overwhelming superiority in every battle across the spectrum of warfare. As such, it will be the centerpiece of the Objective Force.

In this analysis, we will analyze each alternative through the development of metrics of vulnerability across three axes: Environment, Enemy situation, Mission Type. From the design of the resulting graph, we will be able to identify which alternatives have the

lowest point (point of greatest vulnerability) and which is most vulnerable (lowest average vulnerability).

The second analysis will be more subjective, focusing on mission sets and enemy exploitation analysis. By analyzing the concepts through an enemy focus, we will try to develop winning scenarios for the opposing force. This will require ‘out-of-the-box’ strategies and thinking.

### **Results Summary:**

The Program Office-Objective Force asked the Department of Systems Engineering at the United States Military Academy to identify potential operational vulnerabilities in the overall Future Combat System (FCS) concept. Faced with the imminent Lead Systems Integrator decision and given the scope of the problem, the Department recommended, and the Program Office agreed, the best approach to quickly and directly address the issue would be to conduct a workshop. In a workshop format, the participants could analyze the breadth of the problem in a very short period and generate a large amount of data which could then be collected and analyzed.

The workshop, entitled “Building Achilles: Vulnerabilities of the Future Combat System”, was held 16-17 January 2002 at West Point. It brought together 35 individuals from government and academia. The scope was limited to vulnerability identification and did not extend to vulnerability management. In other words, we did not attempt to address means of mitigating or eliminating the vulnerabilities we identified.

The Department was tasked to look at FCS operational vulnerabilities from a unique approach in hopes of uncovering different vulnerabilities not addressed during program development. Our analysis of the FCS, a concept that has been thoroughly analyzed by many different organizations, ran the risk of simply restating or validating previous discoveries. To increase our potential for unique discoveries, it was important to follow different procedures than previous vulnerability analysis efforts.

We separated the workshop participants into two groups, Black and Gold, for initial development of their analytical frameworks. The frameworks were to be very broad to capture all aspects of the FCS concept. Each group would then further separate into two teams. The four teams (Black A/B and Gold A/B) would each refine the analytical frameworks separately and identify vulnerabilities using their frameworks. Thus, very quickly the workshop could develop four different analytical approaches to more completely analyze FCS operational vulnerabilities. We anticipated significant overlap of vulnerabilities and areas of analysis between the teams. We also hoped to uncover some significant vulnerabilities to assist the program in vulnerability management.

The results of this workshop are contained in the white paper prepared for the client, PM, Objective Force. The client requested that we greatly limit dissemination of this report due to its content. We had identified significant, though not insurmountable, vulnerabilities in the FCS program and they should only be released within the program itself.

The follow-up workshop originally scheduled for 7-8 August 2002 was cancelled at the request of the Program Office. According to the client, this was mostly due to the controversial nature of the original workshop and the findings. Recommend that this

analysis continue, in some form. The risks associated with “doing the enemy’s job” though our own internal vulnerability assessment must be weighed against the benefits of objectively working to develop the best system.

**Presentations and Publications:**

- Kwinn, Michael J., Edward Pohl, Greg Parnell, Pat Magras and Rich Richkowski, *Building Achilles: Vulnerabilities of the Future Combat System. A White Paper Summary*, Department of Systems Engineering, US Military Academy, West Point, NY, 31 January 2002.

**Personnel Briefed:**

- BG Donald F. Schenk (PM-Future Combat Systems), 6 February 2002.
- LTG Paul E. Funk (Retired), (Consultant, PM-Objective Force), 7 March 2002.

**Status:** Complete.

# **USMA Acquisition Management Lab Development**

**Client Organization:** Department of Systems Engineering & USMA

**Principal Analysts:** Dr. Niki D. Goerger, Ph.D.,

Mr. Paul West, M.S., and Mr. John Melendez

**Senior Investigator:** LTC Willie J. McFadden II, Ph.D.

## **Points of Contact:**

NAME:	ADDRESS:	PHONE:	OTHER:
Willie J. McFadden	Department of Systems Engineering, USMA	845-938-5534	willie.mcfadden@usma.edu
Niki D. Goerger	ERDC Liaison to TRAC Monterey	831-656-3751	niki.goerger@trac.nps.navy.mil
Paul West	Department of Systems Engineering, USMA	845-938-5871	fp8049@usma.edu
John Melendez	Department of Systems Engineering, USMA	845-938-5872	fj9629@usma.edu

## **Problem Statement:**

The Department of Systems Engineering (D/SE) at the United States Military Academy is dedicated to providing an exceptional academic and research environment for our cadets and faculty. To achieve this vision the D/SE emphasizes a culture of scholarly excellence through its faculty, academic programs, research, and technology initiatives. We have identified a critical military need to conduct research in systems acquisition design and management. The Army is in a transformation process that will position it to remain the world's dominant military force through the 21<sup>st</sup> Century. This transformation requires that our analysis tools be able to assess the potential of new systems much the same way we do today. However, it also requires that we develop systems to function within an integrated, interoperable, multi-echelon information architecture, new force structures and enhanced management and leadership processes. This necessitates that we look to new analytic tools, models, simulations, and federations of tools to effectively analyze the complex issues confronting our transformation efforts. These tools must be linked within a collaborative research and experimental environment that allows for a focused investigation of force structure, knowledge networks, management, and leadership issues within a seamless information architecture.

## **Scope of Work & Methodology:**

We are convinced that there is a need in the acquisition community for an institute dedicated to providing business process analysis and experimentation utilizing existing and in particular new modeling and simulation tools and techniques to shorten and improve the acquisition lifecycle process. The vision of the acquisition systems management institute is to *"develop a acquisition community culture designed to utilize SMART concepts to establish an environment of innovation, knowledge creation, and"*

*information sharing through focused and substantive research on acquisition projects, initial and continued education of cadets, academic faculty, and acquisition professionals, and emphasis on improving the state-of-the-art of modeling and simulation in support of acquisition management and the procurement of systems.”* To this end, we are developing a virtual experimentation and analysis environment that links seamlessly with our suite of constructive simulations to investigate and verify simulation support planning, requirements, concepts, system design, knowledge analysis, measures of performance and effectiveness, and business processes. The acquisition systems management institute will analyze the above issues and other important problems facing program executive officers (PEO) and program managers (PM) over the lifecycle development and force integration of a particular system. The acquisition institute is anchored by the **Acquisition Management & Systems Design (AMSD)** laboratory and a cohort of research professionals, programmers, and support staff, whom are dedicated to working on issues identified by the acquisition community.

### **Results Summary:**

To date a great deal of work has gone into the development of the AMSD Laboratory and the Acquisition Management Institute (AMI). Further development of basic research areas the lab will be capable of supporting are under consideration. However, the technology procured for the lab will be modular and expandable to facilitate research into new areas of research as they may arise.

### **Presentations and Publications:**

- M. Brantley, W.J. McFadden, M. Davis. 2002. “Expanding the Trade Space: An Analysis of Requirements Tradeoffs Effecting System Design,” in the *Acquisition Review Quarterly*, Vol. 28, pg. 1.
- M. Brantley, W.J. McFadden, M. Davis. 2001. Technical Report. A Case Study of the Family of Medium Tactical Vehicles (FMTV) for the Simulation and Modeling for Acquisition, Requirements, and Training (SMART) Initiative, West Point, New York.
- W.J. McFadden, T. Bryant, M. Brantley, S. Vann-Olejasz. 2001. “Acquisition Systems Management: Curriculum Development,” in the *Army Acquisition Logistics and Technology Magazine*, May-June. 24-25.
- M. Brantley. 2001. “FMTV Trade Space Case Study,” SMART Conference.

### **Personnel Briefed:**

- Representative Saxby Chamblis, Georgia, House Armed Service Committee
- Representative Charles Norwood, Georgia, House Education Workforce Committee
- Mr. Hollis, Deputy Undersecretary of the Army (OR)

- LTG Kern, Military Deputy to Asst. Secretary of the Army (ALT)
- Mr. Lunceford, Director, Army Modeling & Simulation Office
- COL Crain, Director, Defense Modeling & Simulation Office
- Stewart & Stevenson, Inc

**Status:** In Progress.

# **A Methodology for Base Camp Site Selection and Facility Layout**

**Client Organization:** The Operations Research Center, Department of Systems Engineering, United States Military Academy

**Principal Analyst:** CPT Frank J. Snyder, M.S.  
**Senior Investigator:** LTC Willie J. McFadden, II, Ph.D.

## **Points of Contact:**

NAME:	ADDRESS:	PHONE:	OTHER:
LTC Willie J. McFadden	Program Director, Engineering Management Program, Department of Systems Engineering	DSN 688-5534 (845) 938-5534	willie.mcfadden@usma.edu

## **Problem Statement:**

In the decade since the end of the Cold War, the number of Support and Sustainment Operations (SASO) and Operations Other Than War (OOTW) conducted by the United States (U.S.) Army (and entire military by extension) has greatly increased. The current trends show no signs of changing, so soldiers in today's Army can expect to spend a significant portion of their careers performing peace enforcement, peacekeeping, humanitarian assistance, and disaster relief missions throughout the world. To maintain a deployed force conducting such (potentially lengthy) operations, the Army has begun constructing semi-permanent basecamps. These camps provide logistical storage, maintenance areas, and soldier support facilities. Despite their obviously important role, there is little to no Army doctrine to determine where a basecamp should be sited geographically or how it should be laid out. The goal of this research is to develop an integrated methodology with a two-fold goal: to help military commanders and planners decide first, where to place basecamps and second, how to layout those basecamps. A methodology has been developed to better site and layout basecamps in support of SASO/OOTW.

## **Scope of Work & Methodology:**

Research the state and future needs of base camp design (site selection and facility layout) to produce a methodology that can assist commanders, staffs, and other planners in making the best decision possible regarding site selection and facility layout. Specifically,

- Perform an extensive literature search and meet with other personnel and organizations (from academia, industry, government, and the military from many countries who have a stake in United States base camp design) to establish a set of valuable requirements and performance measures that are fundamentally important, well-defined, properly scaled, understandable, reliable, and (most importantly) effective.

- Plan and execute several research trips to locations around the world in which the United States builds basecamps to determine better those functions that base camps must accomplish, those features that base camps must possess, and the successes and failures of existing basecamps. Also, use these trips and the existing basecamps at the various locations as test cases for the developed methodology to determine if it could have helped to make a better decision in terms of site selected or layout chosen.
- Assess the role and value of various geographical information systems in executing the methodology.

### **Results Summary:**

Basecamps will continue to play an important role in United States military operations in the Twenty-first Century as the military takes on more support and stability operations and low-intensity missions throughout the world. This research has contributed to the practice of building basecamps and to the effectiveness of such basecamp locations and layouts by providing a step-by-step methodology for how first to select a base camp location and then how to arrange the facilities that compose the basecamp on the site.

Initial indications from subject matter experts and from field research in the Balkans (Croatia, Kosovo, and Macedonia), Central America (Honduras and Belize), and East Timor are that the United States military is doing an adequate job of choosing *good* locations for the majority of its basecamps (especially the big ones like Camp Bondsteel in Kosovo), but in many cases the *best* locations aren't being selected. This methodology provides a process through which the United States military (whether the planners are novices or experts) can select the best sites possible, arrange the sites as best possible, and then defend the selection and design of the site as "the best" according to the developed metrics. Moreover, because the methodology is codified, results are repeatable and consistent.

### **Presentations and Publications:**

- Snyder, Frank J.- DSE Technical Report: A Methodology for Base Camp Site Selection and Facility Layout, September 2002

### **Personnel Briefed:**

- Colonel Robert McClure, Commander of the Engineer Brigade responsible for building many of the United States base camps in the Balkans, 6 April 2002
- Colonel Lloyd Sammons, Commander of Area Support Group Falcon, Camp Bondsteel, Kosovo, 28 June 2002
- Commander Robert Wohlschlegel, United States Pacific Command, J-38 shop, 20 August 2002

**Status:** Complete.

# Army Program Prioritization

**Client Organization:** HQDA, DCSOPS (DAMO-ZR)

**Principal Analyst:** MAJ Brian Stokes, M.S.  
**Senior Investigator:** Dr. Gregory S. Parnell, Ph.D.

## Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER / EMAIL:
COL Bruce Palmatier	HQDA, DCSOPS (DAMO-ZR), The Pentagon	(703) 697-2278	Bruce.Palmatier@HQDA.Army.Mil
Mr. Vernon Bettencourt	HQDA, DCSOPS Technical Advisor	(703) 697-0367	bettevm@hqda.army.mil

## Problem Statement:

The DCSOPS Resource Analysis and Integration Office is the DCSOPS' executive for prioritization of Army programs. Our research focused on two tasks. First to develop a methodology for formulating up-front, comprehensive *Senior Leader Guidance* for use if the Army Program Objective Memorandum (POM) prioritization process that would allow easy dissemination of prioritization Guidance to HQDA Staff. Second, to examine alternative techniques for an objective, credible, and traceable analytical process to prioritize Army programs.

## Scope of Work & Methodology:

1. Senior Guidance Methodology: Our methodology was to identify the types of alternative ways that the Chief of Staff might want to provide guidance and then to develop a prototype tool to demonstrate the methodology.
2. Prioritization Methodology. Develop a prototype design for an objective, credible, and traceable analytical process to prioritize Army programs. Test the prototype on a sample of Army programs. Summarize the results of the evaluation and make recommendations for improved process.

## Results Summary:

- We concluded that the Chief of Staff of the Army (CSA) may want to provide option guidance based on multiple perspectives. We identified several potential perspectives: Total Obligation Authority, Resource Framework, Program Evaluation Group, Quadrennial Defense Review, Defense Planning Guidance, Army Vision. We developed a web-like prototype using an Excel-based, interactive tool. The interactive tool allows the user to determine the multiple perspective navigation sequence that best supports option guidance.

- We researched alternative techniques for prioritization of Army Programs. The four techniques we examined were: Benefit Ratio Method, Multiple Objective Decision Analysis, Mountain of Pain, and Metric Pain. For each technique, we developed a prototype model in Excel to compare each of the methods. We recommended that the client select and prototype one of the techniques to assess the ability to improve Army POM prioritization process.

**Presentations and Publications:**

- Army POM Prioritization Research, Technical Report, Department of Systems Engineering, United States Military Academy, West Point, NYArmy POM Prioritization Research Project, Capstone Project Day, United States Military Academy, West Point, NY, 8 May 2002.Army POM Prioritization Research. Military Operations Research Society Symposium, Ft. Leavenworth, KS, June 18-20, 2002

**Personnel Briefed:**

- LTC Norman Pugh-Newby, HQDA, DCSOPS (DAMO-ZR), May 8, 2002
- Mr. Vernon Bettencourt, HQDA, DCSOPS Technical Advisor, June 18, 2002

**Status:** Planned to continue in AY03.

# Terrorism Threat and Vulnerability Risk Assessment

**Client Organization:** American International Group Consultants, Inc.

**Principal Analyst:** CDT Capstone Team  
**Senior Investigator:** LTC Timothy Trainor, Ph.D.

## Points of Contact:

NAME:	ADDRESS:	PHONE:	OTHER:
Mr. Michael Castelli President	American International Group Consultants, Inc. 175 Water Street – 28 <sup>th</sup> Floor New York, NY 10038	(212) 458-2128	michael.castelli@AIG.com

## Problem Statement:

The insurance industry was significantly affected by the terrorist incidents of September 11, 2001. A great deal of emphasis is now placed on assessing the risk to clients from future potential terrorist activities. AIG Consultants, Inc. asked the Department of Systems Engineering at the United States Military Academy (USMA) to help them develop a methodology to quantify this risk.

## Scope of Work & Methodology:

The project was to develop a threat and vulnerability assessment tool for American International Group. The intent was for one of their consultants to apply a simple, standard assessment of a potential client that would provide a quantitative measure of risk from future incidents. AIG wanted this methodology in the form of a web-based application that could reside on their server and be used by consultants.

The user is asked questions in eight areas of assessment: industry, location, vulnerability, corporate security planning, physical security, personnel security, training, and services. Industry and location scores are generated from a list of options from which the client chooses. The other six area scores are based on the user's answers to a series of questions. Each area has general questions that apply to all industries and then industry-specific questions. The questions are stored in an ACCESS® database, tagged by identifiers so the questionnaires are automatically developed based on initial user inputs. The question and area weights are also stored in the database.

In order to develop an accurate threat and vulnerability score, we had to apply weights to each question and area so that the relative importance to AIG of each aspect of the program is reflected in the final score. We applied the swing weighting methodology to develop these weights. We had AIG weight each question against all of the other questions in each area for all specific industries. We also had AIG weight the areas relative to one another.

The basic methodology involved assessing the risks in a standard set of areas using a series of questionnaires that were tailored to the type industry assessed. Based on the user-entered industry type to assess, a series of industry-specific questionnaires is presented that the user completes by simply choosing an option button. Based on the answers to these questions, a score for an assessment area is developed as a weighted-average of the answers. Question answers are either on a scale from 1-5 (5 is best), or yes-no, with the answers translated into a numerical scale within the tool. Once the user answers the questions in each area by selecting the appropriate option buttons, the tool calculates the weighted-average area scores, and then an overall company risk assessment score as a weighted-average of the area scores.

The tool now resides on the AIG Consultants intranet. We developed a web interface, thanks in large part to assistance from the USMA Department of Electrical Engineering and Computer Science. The web interface formats the questionnaires based on initial user input regarding the location and type of industry. After answering the questions for each area in sequential order, the final screen displays the overall area scores and final risk assessment score.

### **Results Summary:**

The client has the tool and is using it. We have two cadets continuing work on the program as part of an AIAD.

The benefits of this project are that they assist AIG in evaluating potential clients in the face of a terrorist threat, a very real and applicable use. There are also many potential spin-offs from this program. We only developed this assessment for domestic use. It can also be expanded to the international scale. Furthermore, the program and the scores that it generates can be used to make safety recommendations to the client or potential client who can then improve their overall security. AIG plans to link this assessment to a tool called PATROL that will provide clients suggested resources to improve in weak areas identified during their assessment. AIG hopes to eventually enlarge the current program into one that not only assesses client risk but also assigns insurance premiums to those risks.

The benefits of this project are that they assist AIG in evaluating potential clients in the face of a terrorist threat, a very real and applicable use. There are also many potential spin-offs from this program. We only developed this assessment for domestic use. It can also be expanded to the international scale. Furthermore, the program and the scores that it generates can be used to make safety recommendations to the client or potential client who can then improve their overall security. AIG will link this assessment to a tool called PATROL that will provide clients suggested resources to improve in weak areas identified during their assessment. AIG hopes to eventually enlarge the current program into one that not only assesses client risk but also assigns insurance premiums to those risks.

For the Army implications of this project, the web-based program can also be used to judge the safety and security of Army installations. By adding more specific military related information to the program it can perform the same function for the Army that it will be performing for AIG.

**Presentations and Publications:**

- CDTs Kim Caprari, Carson Green, Jason Roth and Curtis Unger, *Developing a Threat and Vulnerability Assessment Tool for the Insurance Industry*, published in the University of Virginia Dept of Systems Engineering Capstone Project Conference Proceedings, o/a May 2002.

**Personnel Briefed:**

- President and staff of AIG Consultants, New York.
- University of Virginia Dept. of Systems Engineering Capstone Conference attendees, May 2002.
- Presented in part at the *Strategic Responses to the Risks of Terrorism Conference*, University of Virginia, April 2002.

**Status:**

This program is ready to be implemented by AIG, but the scores that it develops are not yet validated. Since AIG has no similar assessment data, there is no scale with which to compare them. The next step in implementing this program is to develop benchmarks for the scores generated. That is, AIG will assess clients it considers very safe and see what score is generated. That will help develop a benchmark score for a safe client. They will do the same with a very risky client, thus giving the scores meaning and validating the program. Two cadets are assisting in this process during an AIAD program this summer. Also, MAJ Magras, Dept of Systems Engineering, is attempting to develop an application of this for use as an Army installation risk assessment tool.

# **Using Simulation to Support Security Planning at the United States Military Academy**

**Client Organization:** USMA DOPS

**Principal Analyst:** MAJ Michael E. Nowakowski, M.S.  
**Senior Investigator:** LTC Timothy Trainor, Ph.D.

## **Points of Contact:**

NAME:	ADDRESS:	PHONE:	OTHER:
LTC John Schatzel	Director, DOPS	(845)938-2517	John.Schatzel@usma.edu

## **Problem Statement:**

The events of September 11, 2001 caused the United States Military Academy (USMA) at West Point, New York to significantly increase security measures. The heightened security posture revealed problem areas that required fast, quantifiable analysis that could be used to aid the decision-making process. One particular issue faced by decision-makers was how to allow 30,000+ spectators to attend home football games while enforcing necessary security measures. The problem of estimating the impacts from queues of spectators forming at the USMA entrance gates while vehicles were searched was modeled quickly using discrete-event simulation. Given only a few hours to analyze this problem, quantifiable measures of the expected vehicle queue lengths and wait times and impact on the surrounding road network was provided and used in planning. The USMA purchased metal detectors through which spectators would pass when entering the football stadium. Again in a few hours the problem of locating and manning these detectors and estimating the time to process fans into the stadium was modeled and analyzed using simulation. For both these queuing problems, simulation proved to be an effective tool for modeling the many uncertain parameters, providing quantitative analysis and communicating recommendations to decision-makers in the limited time available.

## **Scope of Work & Methodology:**

Both questions posed by West Point's security decision-makers involve lines - lines of cars waiting inspection at the installation's gates and lines of fans waiting to enter the football stadium. Answering the questions posed was relatively straightforward once models of each problem were built around the three basic elements of queuing theory: customers, servers, and the queue.

To facilitate our recommendations concerning both questions, we estimated two specific measures of performance of the queuing systems. The impact on the surrounding road network is quantitatively assessed by calculating the expected maximum queue length of vehicles waiting to be searched at the gates of West Point. The question of the time to pass all fans through metal detectors is answered by calculating the expected time in the

queuing system for all fans. These measures of performance were easy to determine using the simulation models developed.

We contact the following agencies to assess several parameters needed for the simulation model:

- The Office of the Director of Intercollegiate Athletics (ODIA) provided us with the expected number of vehicles arriving at West Point on game day, along with the distribution of which gate they will enter based on the number and location of parking passes.
- ODIA also provided the number of fans and the distribution for entry into Michie Stadium used in the stadium access model.
- State and local police helped us determine the distribution for incoming routes to West Point, and the distribution of vehicle types (car, van, or bus) coming through the gates.
- West Point military police provided the search times for each of the vehicle types.
- ProModel Corp. provided us with the metal detector model, as well as approximate service times for each of the components in that model.

### **Results Summary:**

Decision-makers needed fast answers to two rather complex problems. The task was to provide quantifiable justification for security decisions. The process of modeling these problems using simulation helped identify the key parameters that influence the outcomes. Based on the insights gained from the models, security planners were able to adjust the plan to maintain a high level of security and process vehicles and people in an efficient manner. For the first game on 6 Oct, approximately 30,000 fans did show up. Realizing all vehicles could not be inspected at the gates based on our analysis, cars were routed well away from the stadium and people rode buses to the game. There was some backlog at the entrances to the stadium as people got used to the concept of going through metal detectors. For the Oct 6th game, most but not all people were processed through the metal detectors by game time. As the season progressed and both workers and fans got used to the system, fans were processed expeditiously through the detectors and into the stadium without significant delays. While the simulation results are only as good as the parameter estimates, the results provide more confidence than intuitive judgment since they account for the interaction of the many parameters affecting the problems. Simulation modeling proved to be an effective means to provide fast, quantifiable answers to the USMA's security dilemmas arising from the events of September 11, 2001.

### **Presentations and Publications:**

- Nowakowski, Michael E. and Trainor, Timothy E. Presentation at the Institute of Industrial Engineers Simulation Solutions Conference, San Diego, CA, April 2002

- Magras, Patrick Presentation and paper in proceedings at the Society for Computer Simulation's Advanced Simulation Technologies Conference, San Diego, CA, April 2002
- Nowatkowski, Michael E. Presentation at the ProModel Solutions Conference, Park City, UT, July 2002
- Buckingham, James, McFadden, Willie, Nowatkowski, Michael E. and Trainor, Timothy E. Published in IIE Solutions, September 2002
- Buckingham, James, McFadden, Willie, Nowatkowski, Michael E. and Trainor, Timothy E. Published in MORS Phalanx, September 2002

**Personnel Briefed:** None

**Status:** Complete.

## **PART III - Faculty Activity, Academic Year 2001-2002**

(\* Indicates multiple department authors)

### **BELKNAP, MARGARET H., PH.D., Lieutenant Colonel**

#### **Refereed Journal Publications**

Belknap, Margaret H., "The CNN Effect: Strategic Enabler or Operational Risk?" *Parameters*, Autumn 2002.

#### **Invited Lecture Series**

Belknap, Margaret H., Chun-Hung Chen, and Patrick T. Harker, "A gradient-based Method for Analyzing Stochastic Variational Inequalities", Third Alan Goldman Lecture, Johns Hopkins University, February 28, 2002.

### **BRENCE, JOHN R., M.S., Major**

#### **Refereed Journal Publications**

Brence, John R. and Brown, Donald E. PhD. "Data Mining Corrosion from Eddy Current Non-destructive Tests." Accepted for publication by *Computers and Industrial Engineering*, 2002.

#### **Refereed Conference Proceedings Publications**

Brown, Donald E., and John R. Brence. *Discovering Corrosion Relationships in Eddy Current Non-destructive Test Data*. Fourth Workshop on Mining Scientific Datasets, Seventh ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, San Francisco, CA, 26 AUG 2001.

Brence, John R. and Donald E. Brown. *Complexity Challenges to the Discovery of Corrosion Relationships in Eddy Current Non-Destructive Test Data*. Mathematical Challenges in Scientific Data Mining, Institute for Pure and Applied Mathematics, University of California, Los Angeles 14-18 JAN 2002.

#### **Conference Presentations**

Brown, Donald E. PhD and John R. Brence. *Discovering Corrosion Relationships in Eddy Current Non-destructive Test Data*. Fourth Workshop on Mining Scientific Datasets, Seventh ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, San Francisco, CA, 26 AUG 2001.

Brence, John R. and Donald E. Brown. *Complexity Challenges to the Discovery of Corrosion Relationships in Eddy Current Non-Destructive Test Data*. Mathematical Challenges in Scientific Data Mining, Institute for Pure and Applied Mathematics. University of California, Los Angeles 14-18 JAN 2002.

## **BUCKINGHAM, JAMES M., P.E., PH.D., Lieutenant Colonel**

### **Refereed Conference Proceedings Publications**

Buckingham, J.\* , McFadden, J., Nowatkowski, M.\* , Trainor, T. *Using Simulation to Support Security Planning at the United States Military Academy*, Advanced Simulation Technologies Conference, April 2002.

### **Non-Refereed Publications**

Buckingham, James M\*. Magras, Patrick\*, *Decision Support System for Security Planning at the United States Military Academy*. Advanced Simulation Technologies Conference in San Diego, CA in Apr 02.

Buckingham, James M.; Han, Pierre; Heppe, Adam; Russ, Charles; and Stroiney, Scott. *Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)*. Capstone Final Report. West Point, New York: Department of Systems Engineering, United States Military Academy, June 2002

Buckingham, James M., *Innovative Application of Existing Technology for Improving Aviation Weather Reporting Systems in Rural Alaska*, Portland International Conference on Management of Engineering and Technology (PICMET), August 2001.

Buckingham, James M., Application of a Web-based Information Technology System for Improving Aviation Weather Reporting Systems in Rural Alaska, 6th International Conference of the Decision Sciences Institute in July 2001.

### **Conference Presentations**

Buckingham, James M., *Innovative Application of Existing Technology for Improving Aviation Weather Reporting Systems in Rural Alaska*, Portland International Conference on Management of Engineering and Technology (PICMET), August 2001.

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. *A Decision Support System for Security Planning at the United States Military Academy*, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

### **Client Presentations**

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Dr. Jon J. Mercurio, Army Research Labs, Chief, Battlefield Environment Division, West Point, NY – 8 May 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Dr. Doug Brown, Army Research Labs, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Mr. Mike Alexander, Army Research Labs, Meteorologist, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Ms. Barbara Sauter, Army Research Labs, Computational and Information Sciences Directorate, Battlefield Environment Division, White Sands Missile Range, NM – 3 Apr 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Mr. John Dragomir, National Weather Service Office, Fairbanks, AK, 20 June 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Ms. Sharon Alden, Fire Protection Services, Bureau of Land Management, Fairbanks, AK – 21 Jun 2002.

Buckingham, James M. "Disposable, Air-Droppable, Meteorological Tower Array (DAMTA)." Presented to Mr. Walt Wilson, Federal Aviation Administration, Anchorage, AK, 24 Jun 2002.

#### **Number of Refereed Conference Proceedings Publications Reviews: 5**

#### **BURK, ROGER C., PH.D.**

##### **Refereed Conference Proceedings Publications**

Stokes, B, Parnell, G\*, & Burk, R\*, "Portfolio Analysis Using Multiple Objective Decision Analysis And Mathematical Programming", Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

##### **Refereed Publication**

Burk, Roger C.; Deschapelles, Carolina; Doty, Karl; Gayek, Jonathan E.; and Gurlitz, Thomas. Performance Analysis in the Selection of Imagery Intelligence Satellites, Military Operations Research, 2002, Vol 7, No 2, pp.45-60.

##### **Non-Refereed Publications**

Burk, Roger C.; Alvear, Christopher; Sheets, Patrick; Walker, Luke; Wolberg, Sarah; and Woodruff, Charles. DSE Technical Report: *Analysis of Alternatives for a Tactical Hybrid UAV/UGV*, in preparation.

##### **Conference Presentations**

Burk, Roger C.; Alvear, Christopher; Sheets, Patrick; Walker, Luke; Wolberg, Sarah; and Woodruff, Charles. Presentation at the Military Operations Research Society, Working Group 10 (Unmanned Systems): *Analysis of Alternatives for a Tactical Hybrid UAV/UGV*, Ft. Leavenworth, KS, 18-20 June 2002

##### **Client Presentations**

Burk, Roger C. "Analysis of Alternatives for a Tactical Hybrid UAV/UGV," Dr. Suzy Young (Deputy Director) and Mr. Al Reed, Advanced Systems Directorate, AMRDEC, May 2002.

## **CARLTON, WILLIAM, B., P.E., PH.D., Colonel**

### **Refereed Conference Proceedings Publications**

Sanders, David M\* and Carlton, William B\* "Information Overload at the Tactical Level." Society for Modeling and Simulation International, 2002 Advanced Simulations Technologies Conference, Military, Government and Aerospace Symposium, April 2002.

Kwinn, M.\* , Pohl, E.\* , Carlton, B.\* , McGinnis, M.\* , "Capstone Design in Education: Systems Engineering and the West Point Way." Proceedings of the International Council of Systems Engineering, Las Vegas, NV, July 2002.

### **Non-Refereed Publications**

Sanders, David M\* and Carlton, William B\* "Information Overload at the Tactical Level." Technical Report – DTIC# ADA405459, August 2002

### **Conference Presentations**

Sanders, David M. and Carlton, William B. "Information Overload at the Tactical Level." Presented at the Society for Computer Simulation's Advanced Simulation Technology Conference, April 2002

Sanders, David M. and Carlton, William B. "Evaluating Information Usage." Presented at the 70th MORSS Symposium, Fort Leavenworth, Kansas, June 2002.

Chris Staab, Jonathan Johnson, Brandon McCray, Matthew Chase, and William Carlton. "Analysis of USMA Cemetery Utilization." Fort Leavenworth, Kansas: Presentation at 70<sup>th</sup> MORSS, 18 June 2002.

### **Client Presentations**

Chris Staab, Jonathan Johnson, Brandon McCray, Matthew Chase, and William Carlton. "Analysis of USMA Cemetery Utilization." Capstone Project Day Briefings, United States Military Academy, May 2002

## **DRISCOLL, PATRICK J., PH.D.**

### **Non-Refereed Publications**

Lamm, Linda, M. J.\* , Gregory A. Lamm\*, and Patrick Driscoll.\* *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology.* Technical Report, Department of Systems Engineering, United States Military Academy, West Point, NY, June 2002.

### **Conference Presentations**

Driscoll, P.J.\* and Pohl, E.A.\* , "Modeling the Decision Quality of Sensor to Shooter (STS) Networks." Presented at the 70th Military Operations Research Symposium, Ft. Leavenworth, Kansas, June 2002.

Driscoll, P.J.\* & E. Pohl.\* "Modeling the Decision Quality in Sensor-to-Shooter (STS) Networks for Unattended Ground Sensor Clusters." Presentation at the 70<sup>th</sup> Military Operations Research Society, Information Operations Working Group

*Modeling Decision Quality of Sensor-to-Shooter (STS) Networks*, Fort Leavenworth, Kansas, June, 2002.

Driscoll, P.J.\* , and E. Pohl.\* "Modeling the Decision Quality in Sensor-to-Shooter (STS) Networks for Unattended Ground Sensor Clusters." Accepted for presentation at the International Conference on Information Quality (ICIQ), MIT, Cambridge, Massachusetts, November, 2002.

### **KLIMACK, WILLIAM K., PH.D., Colonel**

#### **Refereed Conference Proceedings Publications**

Bassham, C. Brian, William K. Klimack, and Kenneth W. Bauer, Jr. "ATR Evaluation Through the Synthesis of Multiple Performance Measures," *Signal Processing, Sensor Fusion, and Target Recognition XI*, Ivan Kadar, editor. Proceedings of SPIE volume 4729. Bellingham, Washington: The International Society for Optical Engineering, April 2002.

Snyder, Frank J.\* , Gregory S. Parnell\*, and William K. Klimack\*. "Modeling Objectives on Cost: Insight for Practitioners and Academicians " Twelfth Annual International Symposium of the International Council on Systems Engineering, Las Vegas, Nevada USA, July 28 -August 1, 2002.

#### **Non-Refereed Publications**

Klimack, W. K, Christopher B. Bassham , Kenneth W. Bauer. *Application of Decision Analysis to Automatic Target Recognition Programmatic Decisions*. Technical Report AFIT/EN-TR-02-01, Air Force Institute of Technology, October 2001

Klimack, William K., Sandra L. Vann-Olejasz, and Frank J. Snyder. *GCSS-A Alternative Evaluation*. Operations Research Center of Excellence Technical Report TR-02-01. West Point: USMA, May 2002.

Klimack, William K. *Hybrid Value-Utility Decision Analysis*. Operations Research center of Excellence Technical Report TR-02-01. DTIC ADA403768. West Point, New York: United States Military Academy, June 2002.

Klimack, William K. "Summary of Observations During SAP Demonstration for GCSS-A User Jury, 7 November 2001." Memorandum Report Number MR-02-01. Operations Research Center of Excellence, Department of Systems Engineering, United States Military Academy, 8 November 2001.

#### **Books or Book Chapters**

Klimack, William K. *Robustness of Multiple Objective Decision Analysis Functions*. DTIC ADA402483. Dissertation, Air Force Institute of Technology, Wright-Patterson Air Force Base, June 2002

#### **Conference Presentations**

Klimack, William K., C. Brian Bassham, and Kenneth W. Bauer, Jr. "ATR Evaluation Through the Synthesis of Multiple Performance Measures," Aerosense Conference, The International Society for Optical Engineering, Orlando, Florida, 1 April 2002.

Klimack, William K., Sandra L. Vann-Olejasz\*, and Frank J. Snyder.\* "Decision Analysis Support for the Global Combat Service Support System – Army," Fort Leavenworth, Kansas: Presentation at 70th MORSS, 18 June 2002.

Klimack, William K., and Jack M. Kloeber, Jr. "Military Relative Risk Aversion," INFORMS Annual Conference, San Jose, California, accepted for 18 November 2002

### **Client Presentations**

Klimack, William K. "Robustness of Multiple Objective Decision Analysis Functions," Presentation, Air Force Institute of Technology, Wright-Patterson Air Force Base, 17 May 2002.

Klimack, William K., and Casey Wardynski. "Unit Rotation Study." To LTG John M. LeMoine, Deputy Chief of Staff, G1, and MG Lawrence Adair, Deputy G1. Washington, DC: The Pentagon, 10 July 2002

### **Tutorials**

Klimack, William K. "Introduction to Design of Experiments," The Value of Test and Evaluation Workshop, The International Test and Evaluation Association, Annapolis, Maryland, 16 July 2002.

**Number of Refereed Journal Publications Reviewed: 3.**

## **KLINGAMAN, RANDALL R., M.S., Major**

### **Refereed Conference Proceedings Publications**

Klingaman, Randall R.\* , and Ricardo Morales, Michael L. McGinnis\*, Barry Ezell. "Cluster Analysis of Joint Tasks for Rapid Decisive Operations," *Proceedings of the IEEE Systems, Man, and Cybernetics Conference*. 2071-2074. Piscataway, New Jersey: IEEE Press, 2001.

### **Conference Presentations**

Klingaman, Randall R.\* , Ezell, Barry C. and McGinnis, Michael L.\* *Cluster Analysis of Joint Tasks for Rapid Decisive Operations*. IEEE Systems, Man, and Cybernetics Conference, Tucson, AZ, 6-10 OCT 2001.

Klingaman, Randall R. *EINSTEIN Model Validation*. 70<sup>th</sup> MORS Symposium, Fort Leavenworth, KS, 18-20 JUN 2002

**Number of Refereed Conference Proceedings Publications Reviews: 5.**

## **KWINN, MICHAEL J. JR., PH.D., Lieutenant Colonel**

### **Refereed Conference Proceedings Publications**

Kwinn, M.\* , Pohl, E.\* , Carlton, B.\* , McGinnis, M.\* , "Capstone Design in Education: Systems Engineering and the West Point Way." *Proceedings of the International Council of Systems Engineering (INCOSE) Conference*, Las Vegas, NV, August 2002.

Beach, J., Nogic, D., Rains, M., Williams, S., and Kwinn, M.J., "Information Technology Training", Proceedings of the International Conference on Systems Engineering (INCOSE) Conference, Las Vegas, NV, August 2002.

### **Non-Refereed Publications**

Kwinn, M. J.\*, Edward Pohl\*, Gregory Parnell\*, Patrick Magras\*, Richard Richkowski.\* *Building Achilles: Vulnerabilities of the Future Combat System*. A White Paper Summary of 16-17 January 2002 Workshop. West Point, New York: Department of Systems Engineering, January 2002

Kwinn, M. J.\*, Edward Pohl\*, Gregory Parnell\*, Patrick Magras\*, Richard Richkowski.\* *Building Achilles: Vulnerabilities of the Future Combat System*. A White Paper Symposium Report, 31 January 2002

Henderson, D., Ulrich, J., Fulcher, C., Kwinn, M.J., Henry, T., McCarthy, D., "The Officer Distribution Plan: Description and Needs Analysis", United States Total Army Personnel Command Technical Report, Alexandria, VA, February 2002

Kwinn, M.J\*, Beckerman, J.B\*, Dodson, C.J., "The Key to a Revolution", Phalanx, June 2002

### **Books or Book Chapters**

Kwinn, M.J\*, Morales, R.O\*, Davis, M.L\*, "So you say you want a revolution...", Chapter 2, Sharpening the Sword: National Security and Military Transformation, ed, Marc Pollak, et al, Center for Emerging National Security Affairs, May 2002

### **Conference Presentations**

Hoempler, K., Lowery, B., Riedel, N., Torres, J., and Kwinn, M. J., "Global Threat Analysis", Presentation for the Military Operations Research Society Symposium, June 2002.

Brockett, P. L., Cooper, W. W., and Kwinn, M. J., "Efficiency and Effectiveness in Military Recruiting", Presentation for the International Forum for Operations Research and the Management Sciences, November 2001.

Brockett, P. L., Cooper, W. W, and Kwinn, M. J., "DEA and Regression Approaches for Evaluating the Effects of Different Military Recruitment Advertising Strategies", Presentation and paper for the Military Personnel Research Symposium, Office of Naval Research, University of Memphis, June 2001.

### **Client Presentations**

Kwinn, M. J. "Vulnerabilities Analysis of FCS Conceptual Design Alternatives." Presentation to BG Donald F. Schenk (PM-Future Combat Systems), 6 February 2002.

Kwinn, M. J. "Vulnerabilities Analysis of FCS Conceptual Design Alternatives." Presentation to LTG Paul E. Funk (Retired), (Consultant, PM-Objective Force), 7 March 2002

### **Professional Society Officer Positions**

Military Operations Research Society (MORS) - Board Member,

**LAMM, GREGORY A., M.S., Major****Non-Refereed Publications**

Lamm, Linda, M. J.\* , Gregory A. Lamm\*, and Patrick Driscoll\*. *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology.* Technical Report, Department of Systems Engineering, United States Military Academy, West Point, NY, June 2002.

**LAMM, LINDA M. J., M.S., Captain****Non-Refereed Publications**

Lamm, Linda, M. J.\* , Gregory A. Lamm\*, and Patrick Driscoll\*. *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology.* Technical Report, Department of Systems Engineering, United States Military Academy, West Point, NY, June 2002.

**Conference Presentations**

Lamm, Linda M.J. Presentation at the Military Operations Research Society, Working Group 10 (Unattended Systems): *Networked Unattended Ground Sensor Fields: Tradeoff Study and Configuration Rules Methodology*, Fort Leavenworth, Kansas, June, 2002

**MAGRAS, PATRICK G., M.S., Major****Refereed Conference Proceedings Publications**

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. *A Decision Support System for Security Planning at the United States Military Academy*, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

**Non-Refereed Publications**

Kwinn, M. J.\* , Edward Pohl\*, Gregory Parnell\*, Patrick Magras\*, Richard Richkowski.\* *Building Achilles: Vulnerabilities of the Future Combat System.* A White Paper Summary of 16-17 January 2002 Workshop. West Point, new York: Department of Systems Engineering, January 2002.

**Professional Society Officer Positions**

Phi Kappa Phi, USMA Chapter, Treasurer.

**Number of Refereed Journal Publications Reviewed: 1**

**MCCARTHY, DANIEL J., M.S ., Major****Refereed Conference Proceedings Publications**

Brockett, P. L. Cooper, W. W., Kumbhakar, S., Kwinn, M. J., and McCarthy, D., "Alternative Statistical Regression Studies of the Effects of Joint and Service Specific Advertising on Military Recruitment", submitted for publication in the Journal of the Operations Research Society (JORS), April 2002

**Non-Refereed Publications**

Henderson, D., Ulrich, J., Fulcher, C., Kwinn, M., J., Henry, T., McCarthy, D., "The Officer Distribution Plan: Description and Needs Analysis", United States Total Army Personnel Command Technical Report, Alexandria, VA, February 2002.

**Number of Refereed Journal Publications reviewed: 1**

**MCFADDEN, WILLIE J., II, PH.D., Lieutenant Colonel****Refereed Conference Proceedings Publications**

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. "A Decision Support System for Security Planning at the United States Military Academy." *Conference Proceedings, Military, Government and Aerospace Simulation*, 2002 Advanced Simulation Technologies Conference, April 2002.

R. Klingaman, W.J. McFadden. 2002. "Agent Based Models: An Alternative Simulation Tool For Engineering Managers," in the *Proceedings of the 1999 American Society for Engineering Management National Conference*, Tampa, Florida, October 2002.

**Non-Refereed Publications**

Buckingham, James\*, Willie McFadden\*, Michael E. Nowatkowski\*, and Timothy E. Trainor.\* "Using Simulation to Support Security Planning at the United States Military Academy." Published in *IIE Solutions*, September 2002.

Buckingham, James\*, Willie McFadden\*, Michael E. Nowatkowski\*, and Timothy E. Trainor.\* "Using Simulation to Support Security Planning at the United States Military Academy." Published in *MORS Phalanx*, September 2002.

Brantley, M., W. J. McFadden, and M. Davis. *A Case Study of the Family of Medium Tactical Vehicles (FMTV) for the Simulation and Modeling for Acquisition, Requirements, and Training (SMART) Initiative*. Technical Report. West Point, New York: Department of Systems Engineering, 2001.

Brantley, M\*, W. J. McFadden\*, and M. Davis\*. "Expanding the Trade Space: An Analysis of Requirements Tradeoffs Effecting System Design," *Acquisition Review Quarterly*, Vol. 28, 2002.

McFadden, W. J.\*, T. Bryant\*, M. Brantley\*, and S. Vann-Olejasz.\* "Acquisition Systems Management: Curriculum Development," *Army Acquisition Logistics and Technology Magazine*, May-June 2001.

## **Conference Presentations**

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. *A Decision Support System for Security Planning at the United States Military Academy*, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

## **Professional Society Officer Positions**

President-Elect, Military Operations Research Society.

## **MCGINNIS, MICHAEL L., PH.D., Colonel**

### **Refereed Conference Proceedings Publications**

Klingaman, Randall R.\*, and Ricardo Morales, Michael L. McGinnis\*, Barry Ezell. "Cluster Analysis of Joint Tasks for Rapid Decisive Operations," *Proceedings of the IEEE Systems, Man, and Cybernetics Conference*. 2071-2074. Piscataway, New Jersey: IEEE Press, 2001.

Kwinn, M.\* , Pohl, E.\* , Carlton, B.\* , McGinnis, M.\* , "Capstone Design in Education: Systems Engineering and the West Point Way." Proceedings of the International Council of Systems Engineering, Las Vegas, NV, July 2002.

## **Conference Presentations**

Klingaman, Randall R.\* , Ezell, Barry C. and McGinnis, Michael L.\* *Cluster Analysis of Joint Tasks for Rapid Decisive Operations*. IEEE Systems, Man, and Cybernetics Conference, Tucson, AZ, 6-10 OCT 2001.

## **NOWATKOWSKI, MICHAEL E., M.S., Major**

### **Non-Refereed Publications**

Buckingham, James\*, Willie McFadden\*, Michael E. Nowatkowski\*, and Timothy E. Trainor.\* "Tackling Safety with Simulation." Published in *IIE Solutions*, September 2002.

Buckingham, James\*, Willie McFadden\*, Michael E. Nowatkowski\*, and Timothy E. Trainor.\* "Simulation Supports Security Plans for Army Football" Published in *MORS Phalanx*, September 2002.

## **Conference Presentations**

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. *A Decision Support System for Security Planning at the United States Military Academy*, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

Nowatkowski, Michael E.\* and Trainor, Timothy E.\* "Using Simulation to Support Security Planning at the United States Military Academy." Presentation at the

Institute of Industrial Engineers Simulation Solutions (IIE)Conference, San Diego, CA, April 2002.

Nowatkowski, Michael E. "Modeling Traffic Under Heightened Security Measures at the United States Military Academy." Presentation at the ProModel Solutions Conference, Park City, UT, July 2002.

### **Professional Society Officer Position**

Armed Forces Communications-Electronics Association (AFCEA) - Treasurer.

## **PARNELL, GREGORY S., PH.D.**

### **Refereed Journal Publications**

Parnell, G., Gimeno, B., Westphal, D., Engelbrecht, J., & Szafranski, R., Multiple Perspective R&D Portfolio Analysis for the National Reconnaissance Office's Technology Enterprise, *Military Operations Research*, 2001, Vol 6, No 3, pp. 19-34.

Parnell, G., Practice Abstract, "Work Package Ranking System for the Department of Energy's Office of Science and Technolgy," *Interfaces*, 2001, Vol 31, No 4, July-August 2001, pp. 109-111.

### **Refereed Conference Proceedings Publications**

Stokes, B\*, Parnell, G\*, & Burk, R\*, "Portfolio Analysis Using Multiple Objective Decision Analysis And Mathematical Programming", Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

Snyder, F. J\* & Parnell, G. S\*, "Modeling the Cost Objective in a Decision Maker's Value Structure, Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

Snyder, F. J\* & Parnell, G. S\*, "Modeling the Cost Objective in a Decision Maker's Value Structure, " Eleventh Annual International Symposium of the International Council on Systems Engineering, Melbourne, Australia, July 1-5, 2001

Parnell, G. S., "Creating High Value Future Architectures, " Eleventh Annual International Symposium of the International Council on Systems Engineering, Melbourne, Australia, July 1-5, 2001

### **Non-Refereed Publications**

Stokes, B\*, Parnell, G. S\*, & Klimack, W. K\*, *Alternative Resource Allocation Techniques*, Operations Research Center Technical Report, DSE-TR-02-05, United States Military Academy, August 2002

### **Conference Presentations**

Snyder, F. J\*, Parnell, G. S\*, & Klimack, W. K\*, "Modeling the Cost Objective: Insight for Practitioners and Academicians, Military Operations Research Society, Fort Leavenworth, KS, Jun 2002

Stokes, B\*, & Parnell, G. S\*, "Allocating The Army Budget, Insights Into Understanding And Realizing A Decision Maker's Values In A Complex Decision Environment," Military Operations Research Society, Fort Leavenworth, KS, Jun 2002

Snyder, F. J\*, Parnell, G. S\*, & Klimack, W. K\*, "Modeling the Cost Objective: Insight for Practitioners and Academicians, Annual International Symposium of the International Council on Systems Engineering, Las Vegas, Nevada, July 28-August 1, 2002

Stokes, B\*, Parnell, G\*, & Burk, R\*, "Portfolio Analysis Using Multiple Objective Decision Analysis And Mathematical Programming", Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

Snyder, F. J\* & Parnell, G. S\*, "Modeling the Cost Objective in a Decision Maker's Value Structure, Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

### **Client Presentations**

Stokes, B\*, and Gregory S. Parnell.\* "Army POM Prioritization Research." Presentation to LTC Norman Pugh-Newby, HQDA, DCSOPS (DAMO-ZR), May 8, 2002

Stokes, B\*, and Gregory S. Parnell.\* "Army POM Prioritization Research." Presentation to Mr. Vernon Bettencourt, HQDA, DCSOPS Technical Advisor, June 18, 2002

### **Professional Society Officer Positions**

President Elect, Decision Analysis Society, INFORMS, 2002-2004

Council Member, Decision Analysis Society of INFORMS, 2000-2002.

Military Applications Society, Counselor at Large, 1998-2002

**Number of Refereed Journal Publications Reviewed: 4.**

### **POHL, EDWARD A., PH.D., Lieutenant Colonel**

#### **Refereed Conference Proceedings Publications**

Cassady, C.R., Pohl, E.A., "Setting Maintenance Resource Limits for Component Level Selective Maintenance" *Proceedings of the 2002 Industrial Engineering Research Conference*, Orlando, FL, May 2002.

Durkee, D.P., Pohl, E.A., Mykytka, E.F., "Input Data Characterization Factors Affecting Availability Estimation Accuracy," *The Proceedings of the 2002 Reliability and Maintainability Symposium*, Jan 2002, pp 80-89.

Kwinn, M.\*, Pohl, E.\*, Carlton, B.\* , McGinnis, M.\* , "Capstone Design in Education: Systems Engineering and the West Point Way." *Proceedings of the International Council of Systems Engineering (INCOSE) Conference*, Las Vegas, NV, July 2002.

## **Non-Refereed Publications**

Cassady, C.R., and Pohl, E.A., "Introduction to Repairable System Modeling", IEEE Tutorial Notes, *48<sup>th</sup> Reliability and Maintainability Symposium*, Seattle, WA. January 2002.

Kwinn, M. J.\* , Edward Pohl\*, Gregory Parnell\*, Patrick Magras\*, Richard Richkowski.\* *Building Achilles: Vulnerabilities of the Future Combat System. A White Paper* Summary of 16-17 January 2002 Workshop. West Point, new York: Department of Systems Engineering, January 2002.

## **Conference Presentations**

Durkee, D.P, Pohl, E.A., Mykytka, E.F., "Input Data Characterization Factors Affecting Availability Estimation Accuracy," Presented at the 2002 Reliability and Maintainability Symposium, Jan 2002.

Driscoll, P.J.\* and Pohl, E.A.\* , "Modeling the Decision Quality of Sensor to Shooter (STS) Networks." Presented at the 70th Military Operations Research Symposium, Ft. Leavenworth, Kansas, June 2002.

Driscoll, P.J. and Pohl, E.A., "A Mathematical Programming Approach to Reliability Systems Design." International Federation on Operations Research Symposium (IFORS), Scotland, July 2002.

## **Tutorials**

Cassady, C.R., and Pohl, E.A., "Introduction to Repairable System Modeling", IEEE Tutorial Notes, *48<sup>th</sup> Reliability and Maintainability Symposium*, Seattle, WA. January 2002.

## **Professional Society Officer Positions**

Associate Editor for MORS *Journal*

*Institute of Industrial Engineering*, Quality Control & Reliability, Deputy Division Director

**Number of Refereed Journal Publications Reviews:** 1.

**Number of Refereed Conference Proceedings Publications Reviews:** 20.

## **RICHKOWSKI, RICHARD, M.S., Captain**

### **Non-Refereed Publications**

Kwinn, M. J.\* , Edward Pohl\*, Gregory Parnell\*, Patrick Magras\*, Richard Richkowski.\* *Building Achilles: Vulnerabilities of the Future Combat System. A White Paper* Summary of 16-17 January 2002 Workshop. West Point, new York: Department of Systems Engineering, January 2002.

**SANDERS, DAVID M., M.S., Major****Refereed Conference Proceedings Publications**

Sanders, David M\* and Carlton, William B\* "Information Overload at the Tactical Level." Society for Modeling and Simulation International, 2002 Advanced Simulations Technologies Conference, Military, Government and Aerospace Symposium, April 2002.

**Non-Refereed Publications**

Sanders, David M\* and Carlton, William B\* "Information Overload at the Tactical Level." Technical Report – DTIC# ADA405459, August 2002

**Conference Presentations**

Sanders, David M. and Carlton, William B. "Information Overload at the Tactical Level." Presented at the Society for Computer Simulation's Advanced Simulation Technology Conference, April 2002

Sanders, David M. and Carlton, William B. "Evaluating Information Usage." Presented at the 70th MORSS Symposium, Fort Leavenworth, Kansas, June 2002.

**Professional Society Officer Position**

INFORMS Student Chapter OIC

**SNYDER, FRANK J., M.S., Captain****Refereed Conference Proceedings Publications**

Snyder, Frank J.\* and Gregory S. Parnell\* "Modeling Objectives on Cost in a Decision Maker's Value Structure" Eleventh Annual International Symposium of the International Council on Systems Engineering, Melbourne, Australia, July 2001.

Snyder, Frank J.\*, Gregory S. Parnell\*, and William K. Klimack\*. "Modeling Objectives on Cost: Insight for Practitioners and Academicians" Twelfth Annual International Symposium of the International Council on Systems Engineering, Las Vegas, Nevada USA, July 2002.

**Non-Refereed Publications**

Klimack, William K\*, Sandra L. Vann-Olejasz\*, and Frank J. Snyder\*. *GCSS-A Alternative Evaluation*. Operations Research Center of Excellence Technical Report DSE-TR-02-06. West Point: USMA, May 2002.

Snyder, Frank J. *A Methodology for Base Camp Site Selection and Facility Layout*. Operations Research Center of Excellence Technical Report DSE-TR-02-01. September 2002.

**Conference Presentations**

Snyder, Frank J\* and Gregory S. Parnell\* "Modeling Objectives on Cost: in a Decision Maker's Value Structure". Presentation for the American Society for Engineering Management, Huntsville, AL, October 2001.

Snyder, Frank J\* and Gregory S. Parnell\* "Modeling Objectives on Cost in a Decision Maker's Value Structure". Presentation for the International Forum for Operations Research and the Management Sciences, Miami, FL, November 2001.

### **Client Presentations**

Snyder, Frank J. "A Methodology for Base Camp Site Selection and Facility Layout." Presentation to Colonel Robert McClure, Commander of the Engineer Brigade responsible for building many of the United States base camps in the Balkans, 6 April 2002.

Snyder, Frank J. "A Methodology for Base Camp Site Selection and Facility Layout." Presentation to Colonel Lloyd Sammons, Commander of Area Support Group Falcon, Camp Bondsteel, Kosovo, 28 June 2002.

Snyder, Frank J. "A Methodology for Base Camp Site Selection and Facility Layout." Presentation to Commander Robert Wohlschlegel, United States Pacific Command, J-38 shop, 20 August 2002.

## **STOKES, BRIAN J., M.S., Major**

### **Refereed Conference Proceedings Publications**

Stokes, B, Parnell, G\*, & Burk, R\*, "Portfolio Analysis Using Multiple Objective Decision Analysis And Mathematical Programming", Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

### **Non-Refereed Publications**

Stokes, B\*, Parnell, G. S\*, & Klimack, W. K\*, *Alternative Resource Allocation Techniques*, Operations Research Center Technical Report, DSE-TR-02-05, United States Military Academy, August 2002

### **Conference Presentations**

Stokes, B\*, & Parnell, G. S\*, "Allocating The Army Budget, Insights Into Understanding And Realizing A Decision Maker's Values In A Complex Decision Environment," Military Operations Research Society, Fort Leavenworth, KS, Jun 2002

Stokes, B\*, Parnell, G\*, & Burk, R\*, "Portfolio Analysis Using Multiple Objective Decision Analysis And Mathematical Programming", Proceedings of the American Society for Engineering Management Conference 2001, Huntsville, Alabama, October 11-13, 2001.

### **Client Presentations**

Stokes, B\*, and Gregory S. Parnell.\* "Army POM Prioritization Research." Presentation to LTC Norman Pugh-Newby, HQDA, DCSOPS (DAMO-ZR), May 8, 2002

Stokes, B\*, and Gregory S. Parnell.\* "Army POM Prioritization Research." Presentation to Mr. Vernon Bettencourt, HQDA, DCSOPS Technical Advisor, June 18, 2002

## **TRAINOR, TIMOTHY, PH.D., Lieutenant Colonel**

### **Refereed Conference Proceedings Publications**

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. A Decision Support System for Security Planning at the United States Military Academy, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

### **Conference Presentations**

Nowatkowski, Michael E.\* and Trainor, Timothy E.\* "Using Simulation to Support Security Planning at the United States Military Academy." Presentation at the Institute of Industrial Engineers Simulation Solutions Conference, San Diego, CA, April 2002.

Trainor, Timothy. "Terrorism Threat and Vulnerability Risk Assessment." Presentation to University of Virginia Dept. of Systems Engineering Capstone Conference attendees, May 2002.

Trainor, Timothy. "Terrorism Threat and Vulnerability Risk Assessment." Presented as part of the Strategic Responses to the Risks of Terrorism Conference University of Virginia, April 2002.

Magras, P. G\*, James Buckingham\*, Willie McFadden\*, Michael Nowatkowski\*, and Timothy Trainor\*. *A Decision Support System for Security Planning at the United States Military Academy*, Conference Proceedings, Military, Government and Aerospace Simulation, 2002 Advanced Simulation Technologies Conference, April 2002.

### **Client Presentations**

Trainor, Timothy. "Terrorism Threat and Vulnerability Risk Assessment." Presentation to president and staff of AIG Consultants, New York.

## **SANDRA L. VANN-OLEJASZ, M.B.A, Major**

### **Non-Refereed Publications**

Vann-Olejasz, Sandra L. "Logistics Down Under", Army Logistian, June-July 2002.

Vann-Olejasz, Sandra L. *Enhanced Use Leasing*. Technical Report DSE-TR-02-07. West Point, New York: Department of Systems Engineering, United States Military Academy, September 2002.

### **Conference Presentations**

Vann-Olejasz, Sandra L., Degrazio, Barry, and Kitzman, Tara. "Enhanced Use Leasing," How to Select the Best Developer." Presentation at the University of Virginia Capstone Conference, April 2002.

Vann-Olejasz, Sandra L., and Elizabeth W. Schott. "Determining Inventory Levels: Do we have the right criteria?" . Fort Leavenworth, Kansas: Presentation at 70<sup>th</sup> MORSS, 20 June 2002.

## **Client Presentations**

Vann-Olejasz, Sandra L. "Enhanced Use Leasing." Presentation to Mrs. Sharon Weinhold (Principal Deputy – ASA(FM&C) and Mr. Alan King (Deputy Garrison Commander, Walter Reed Army Medical Center) IPR and Interim Analysis of Process Steps – 13 Nov 2001.

Vann-Olejasz, Sandra L. "Enhanced Use Leasing." Presentation to Mr. Erich Kurre (ACSIM) Process Timelines – January 2002

Vann-Olejasz, Sandra L. "Enhanced Use Leasing." Presentation to Mrs. Sharon Weinhold, & Mrs. Deb Ramirez (ASA(FM&C) , Mr. Bill Johnsen (ACSIM) IPR and Process References – 5 February 2002

Vann-Olejasz, Sandra L. "Enhanced Use Leasing." Presentation to Mrs. Deb Ramirez & Mrs. Mary Engoglia (ASA(FM&C) , Mr. Bill Johnsen (ACSIM) Developer Selection – 8 May 2002

Vann-Olejasz, Sandra L. "Enhanced Use Leasing." Presentation to Mrs. Sharon Weinhold, & Mrs. Mary Engoglia (ASA(FM&C), Mr. Bill Johnsen (ACSIM) Final Products and Outbrief – 28 June 2002

## PART IV - Distribution List

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